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A TREATISE Concerning the MOTION OF THE Seas and Winds.

Written in Latine by *Isaac Vossius*: And Translated for the use of the Publick, but particularly such as go to *Sea*.

LONDON,
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TO THE

Right Honourable *GEORGE* Lord *BERKELEY*, Lord of *Berkeley*, *Mowbray*, *Seagrave*, and *Bruce*, *Custos Rotulorum* of the Counties of *Glouceſter* and *Surrey*: and Governour of the *LEVANT COMPANY*.

My Lord.

IT is not vanity to be in the faſhion now a days ſo univerſall, that as Taverns and fair Shops render themſelves remarkable by the Beauty and Coſtlineſs of their Signs, ſo Books juſtle

into publick view under the liberty of a conſpicuous Dedication, that gives me the boldneſs to preſent this Tranſlation to your Lordſhip, and under your honourable name to the Engliſh Reader. *Though your Lordſhip's noble vertues (too many in reſpect of your modeſty and my inſufficiency to to be here particularly named), which render your honour worthy of that degree in this Kingdom, that ſo many and famous Anceſtors through ſo many ages have tranſmitted pure and unſtained, to receive a new luſtre in your Lordſhips perſon; might make me juſtly to be ſuſpected guilty of that ambition. But it is, my Lord, the ſubject of the diſcourſe, acceptable (no doubt) to all the ingenious, and very uſeful to ſuch as are converſant in, or curious to know the viciſſitudes of the* Seas *and* Winds, *with their cauſes and ſeaſons; that prompts me to adventure the offering of it to your Lordſhip, who by reaſon of the conſpicuous rank you bear in thoſe two illuſtrious Bodies, the Honourable* Eaſt-India

India *and* Levant *Companies of this Kingdom, under his Majesty, the great promoters of Trade and Navigation; as their representative may doubly honour it with a publick patronage: that as by the favour of your Lordships protection it may be more esteemed of those skilfull and industrious, who under the Auspices of our Lordships Companies descend into the deeps, and to whom it may prove usefull. So I may likewise in imitation of the learned Author, give it an address parallel to it's orginal dedication, for the same reasons that are mentioned by him, and are needless here to be repeated to your Lordship.*

I confess, my Lord, when at first I was told, that the Treatise might deserve a patron also in this Countrey, I was not so pert, having never had the honour to be known to your Lordship, to think of prefixing your Lordships name to this Translation; until the learned and worthy Person who advised me to the undertaking, suggested to me likewise the suitableness of the dedication.

And these are the reasons, My Lord, which give me confidence to hope, that your Honour will vouchsafe for the sake of the Treatise, to pardon the boldness of him who by presenting it in English *to your Lordship, desires to give a small proof of the great passion he hath to be reckoned,*

My LORD,

Your Lordships

Most humble obedient

and devoted Servant

Arch. Lovel.

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TO THE

Most illustrious and mighty Lords, the States of *Holland* and West *Friesland*.

Most illustrious Lords,

I am not ignorant that in this age aswell as in all others, there are many that will condemn an endeavour to explain the Seas and Winds, as a rash and vain attempt, seeing they take it for certain that most of the motions which are observed in the Air and Waters are uncertain, fickle and tyed to no constant rules. Yet if lovers of Truth will be pleased but to vouchafe a little study to ponder and contemplate those things, which because they are not sufficiently enquired into, appear fortuitous; they will be forced even against their wills, to acknowledg that there is a noble and constant order of nature, which suffers nothing to happen by chance or fortune; and that she being the lady, and mistris of things is not so unadvised as to do any thing rashly, but that she does rather so faithfully execute the laws prescribed by the great Creator to every being, that if at any time she seem to deviate, it is not nature her self, but our opinion and judgment of her that ought to be blamed. This hath therefore kindled in me a desire more accurately to pry into

the concerns of the principal motions which happen in the Ocean, and to try if there be any way to reduce what in a ſcattered and tumultuary manner have been obſerved by others, into ſome commodious (if not) certain method. Although indeed this fluid Element ſeems to baffle and ſcorn the meaſures of humane underſtanding, and that the cauſes which move and ſtir the Ocean ſeem ſo hidden, that ſome have purpoſely ommitted the explication of it; and that whilſt others with more confidence than ſucceſs making their inquires into it, and lanching forth into the Ocean without ſufficient ſtore of Proviſions, have made Shipwrack of their fame and credit, though they have eſcaped the danger of the Waters: Nevertheleſs the example of ſuch does not terrifie me, from declaring of my thoughts publickly, and ſo much the more boldly, that I have diſcovered in thoſe who have ſet upon the handling of this ſubject, a great ignorance even of the hiſtory of the motions of the Seas, and that they have haſtened to the illuſtrating of the cauſe, before the exiſtence of the thing was ſufficiently known. What on this ſubject I have performed, I ſubmit to the judgment of any man, rather than my own; for I am not ſo fond of my own performances, as now and then not to call to mind, that men are never more miſtaken than about their own affairs. But what cenſure ſoever this my ſmall labour may meet with, yet I make no doubt to

preſent

present it to your most Illustrious Lordships, not only because my obedience and duty so engageth me, but also because it treats of a subject which of all men living concerns most your people. Whersoever the Seas do reach, and the Sun shine, thither do your ships go, neither is their course stopt or ended, but where nature her self self sets up her limits. If the number of them be considered it is so great, that all the Ships of Europe mustered into one body, cannot equal the number of Dutch Vessels. And though the Navies of your people be so vast and numerous, yet do they injury to no man unless first provoked. They run over and search all the corners and creeks of the Ocean, not to bring damage to any, but advantage and profit to themselves, and thereby to all mankind. Yet though your mariners by their care and vigilance seem to have already attained to this, that with more success than any other nation they sail the Seas, and that it be the common opinion, that the Ocean receives no Fleets with a more smiling countenance, than what set out from your ports, yet it can hardly be otherways, but that amongst so many thousand Ships, and so many Myriades of Sea-men, the inseparable misfortunes of Navigation should not sometimes happen. Notwithstanding they are not to be imputed to the Seas and Winds, which in the greater part of the inhabited World, are pretty regular and constant, but to the fault either of the commanders

ders or Sea men, who being ignorant of the flowings and ebbings of the Sea, do blindly and to their own hurt sometimes give and receive orders. For I think the more skilful Navigators will freely confess that the greatest Shipwracks that do happen at Sea, do for the most part proceed from the ignorance of the seasons, and of the courses of the Winds and Ocean. And they will also acknowledg that it is safer sailing on the Sea in a boat of Reeds where skill is not wanting, than in a large and well built ship, whose commander is ignorant of the alterations that happen in the Seas and Air. But to what purpose should I discourse of this to your most Illustrious Lordships who know all these things to the full, and do unanimously wish for the good of your people that some art might be found out, that might afford so great confidence and security to saylers, that they might no more be affraid of the motion of the Seas, than of that of the Earth. But seeing this is not to be performed by Human reason, it will at least be no crime to have published somewhat (how little soever) for the good of life, and whereby any profit may be reaped. I hope you will not then take in ill part these my undertakings, especially if I may seem to have bestowed any thing besides my good will. And if my hopes deceive me not, and that I do but receive the least approbation, I shall not only be well satisfied, but much inflamed with a desire hereafter to set

upon

upon the same, and many other things relating to this subject, somewhat more accurately and largely. But if otherwise this my endeavour seem fruitless, yet shall I not neglect the duty of a good commonwealths man, but incessantly pray that your most Illustrious Lordships and Commonwealth may enjoy continual prosperity.

Most Illustrious
and Mighty Lords,

Your Lordships

most humble Servant

ISAAC VOSSIUS.

THE

The Author to the Reader.

Reader.

THough I be ignorant what Title to give you, yet will I beſpeak you by that name which ſeems moſt ſutable to equity and cuſtom. Nevertheleſs I am ſo far from believing that moſt of you will be favourable and kind to me, that I am even perſwaded that at preſent there are ſome, who under colour of honour and good will, do ſecretly lye in wait for my writings, whetting already their venemous Teeth, that with the breath of a peſtiferous and pyſonous breaſt, they may either kill, or render hateful and maimed all the births of my diligence, even before they ſee the light. It may be you expect that with a great Train I ſhould march out againſt ſuch, and revenge my ſelf of ſo great an injury: but if you think ſo you are much miſtaken, for I take it not to be my concern to ſet upon thoſe who declare War, not againſt me, but truth it ſelf. If I be not miſinformed by ſome friends, there live in ſome Colleges a certain kind of Men, who have mutually combined by oath, to admit of no truth which comes from my hands. And although they diſſent amongſt themſelves in opinion, yet they agree to brand the moſt part of my writings (though they underſtand them not) with the name of erroneous and meer impoſtures. Should I not deſerve to be laughed at, if I covered revenge of ſuch men, who by plucking out their own eyes court a voluntary blindneſs? Truly if out of hatred to me they hate truth it ſelf; I wiſh them no worſe, nor my ſelf no better, than that they may enjoy their own humour, and continue ſtill to perſecute me with the greateſt hatred

But to return again to you (candid Reader), I think I need not uſe any long preface with you, ſince

since without it I hope this my small work would not prove unacceptable, which if you do not approve, at least you cannot condemn my purpose and endeavour in it. In the handling of the subject which I have hear undertaken, I have not followed the pattern of others; who suppose many things which neitherdo exist, nor if they did, would they untie but rather perplex the knots and doubts which every where occur. Here you shall find no influences of Stars, as they call them, or occult qualities or magnetismes, I refer all to the Sun and ballance of Waters. Nor do I here alleadge any motion of the Seas and Winds, which I could not if it were necessary, confirm by infinite Testimonies and experiments of Sea men; so that on this account I dare boldly promise, that I have affirmed nothing rashly. If you grant me only one thing, that is that the Sun does warm, and that the Water as other bodies is thereby dilated, and by that means a motion produced, I crave no more the rest will follow of their own accord. Yet if there be any thing that hath escaped me, or that is not exactly enough handled, I earnestly beg of you, that if in so great a croud of things, attempting so unknown and slippery ways, I may have somewhere made a slip, or a little mistaken the right path, you would not charge me with it as a fault. Writers themselves acknowledg how uncertain and frail the thoughts of men are on this subject, when some of them spare not to call their own writings riddles. But I hope Reader how severe soever you may be, you will be kinder thanto asperse this my undertaking with the like Title, & think that I have mispent my time in publishing of mere conjectures. If therefore you think that I have observed any thing that deservers your Ears and approbation, itis all I desire of you, and you will thereby make me more easily digest the opinions of those who are of a contrary judgment.

ERRATA,

The Reader is desired when in this Book he meets with Parama, Cowgo, Terd, Iudus, *he would read* Panama, Congo, Verd, Indus; *and by the sense correct some other mistakes which have escaped the press especially of* Tener *which should be oftener.*

Page 2. l. 14 for Parama read Panama. p. 7 l. 3. r. a streight course, p. 8 l. 8 r. neither is. p. 9. l. 13 r. on the coast, p. 10 l. 22 r. according to his declination, p. 12 l. 2 r. another motion, p. 13 l. 18 r. *New-Holland*, p. 26 l. 12 r. Congo, ibid l. 19 r. *Cape de verd*, p. 31. l. ultima, r. flow, p. 35 l. 19. r. and thus makes up by degrees the ebb whereof we have spoken, p. 40 l. 12 r. *Guyana*, p. 47 l. 18 r. *Archipelago*, p. 56 l. 3 r. current. p. 68 l. 9 r. and fill the glass. p. 73 l. 13 r. that is to say, p. 74 l. 10 r. *Mael-stroomen*, p. 92 l. 21 r. therefore, p. 98 l. 13 for should mount, read should not mount, p. 103 l. 2. for *Judus* r. *Indus*, p. 119 l. 11 for 14 15 r. 13 16*ths* p. 125 l. 2 for first read fourth p. 128 l. 5. and elsewhere where the same occurs, for contract read contact. p. 130 l. 25 for diverting read directing. p. 131 l. 11 for on r. no. p. 132 l. 1 r. preceed for proceed. p. ibid l. 5 for mutant read innatant p. 135 l. 21 for *Cowgo* read *Congo*. p. 141 l. 12 r. the course p. 43 l. 13 read have done. p. 147 l. 14 for race, read trace. p. 150 l. 3. for of r. to. p. idem: and elsewhere for *Aireal*, read *Aeral* p. 159 l. 14 for from such effects, read from which such effects. p. 163 l. last, for rains r. reigns. p. 164 l. 26. for *Papna* r. *Papua*. p. 169 l. 13. for of Tener r. oftener. p. 176 l. 22 for therfore r. although p. 178. l. 18 for Shores r. Showres. p. 189. l. 9. for asserted r. affected. In the Epistle, p. 2. l. 1. for liberty r. livery. p. 3 l. 8. for our Lordships, read your Lordships.

A TREATISE Of the MOTION Of the Seas and Winds.

CHAP. I.

Of the Perpetual Motion in the Torrid Zone.

THE first and chief Motion of the Sea and Winds, is that which between the Tropicks constantly and perpetually follows the Sun; and

were it not for the impediment of Land, would with a continued circulation surround the whole Globe of the World. Although this Motion is every-where discernable in the Torrid Zone, yet it is no-where brisker, or more manifestly perceived, than in the Pacifick Sea which lies betwixt *Peru*, or the Western Coast of *America*, and the *Molucca* Islands. For all this space of Sea, which reacheth above two thousand *German* Leagues, Ships that sail from *Lima*, *Parama*, or *Acapulco*, do in three months, and sometimes sooner pass over. The same Easterly Wind, and Current of the Sea bending constantly to the West, waits on them to the *Molucca*'s, and even to the Coasts of *India*. And they who from the *Molucca* and other Islands of the *Indies*, direct their course to the *Cape* of *Good Hope*, are carried by the same Wind and Current. And though in the *Indian* and Red Seas, this Wind and Current decline some-

what

what towards the South, (as we shall hereafter shew), yet it still persists in its course; and is continually hurried towards the West. The remaining and third part of the Ocean, which is bounded by the *Cape of Good Hope* and *Brasil*, or rather the Western Shoar of *Africa*, and the opposite Coasts of *America*, which lies under the Torrid Zone, observes perpetually the same rule, for here also the course of the Winds and Sea tends continually Westward.

So that if a person skilful in Navigation, and of the seasons in the several places of the World, should resolve to go round it, I think it is not to be doubted, but that in the space of nine or ten months he might accomplish his design; provided he so ordered his course, as in a convenient season, that is, in the month *December* or *January*, he might pass the Southern Streights of *America*. But if any one should in the same Line undertake a contrary course,

and ſail againſt the Sun from Weſt to Eaſt, he could not in twenty years ſpace, and it may be never, be able to perform his Voyage.

The reaſon of this Motion is juſt another thing than ſome do believe, to wit, the Sun being juſt over head, drinks up the Waters of the Ocean and makes a Cavity, which the following Waves ought to fill: For if this were, the Seas ſhould not move to the Weſt, but Eaſt. For ſeeing theſe parts of the Ocean which the Sun hath not as yet touched with his perpendicular beams, muſt by this reaſon become higher than thoſe others to which the Sun is, or lately was vertical, and therefore are more low and depreſſed; it muſt neceſſarily follow, that the Seas of the Torrid Zone ought to flow Eaſtward, ſince naturally all Motion tends from the higher to the lower.

But the matter is far otherways, and the reaſon which forceth the Sea Weſtward is quite contrary: For though the Sun by his heat attract

and

and ſeparate the more ſubtil parts of the Water, yet he does not depreſs or leſſen the ſuperfice and height of the Sea, but rather dilates and raiſes it. Whereſoever the Sun is perpendicular, there is the greater ſwelling of the Ocean; and where the Sun is fartheſt removed from his perpendicularity, there do the Seas fall, and ſink even ſomewhat lower than they were before. Therefore when theſe Seas to which the Sun is, or lately before was perpendicular, are raiſed higher than the ſurface of the Ocean which reacheth to the Weſt, and hath not as yet felt the beams of this Luminary; it comes to paſs neceſſarily, that the Floods ſhould rowl from a higher ſurface to a lower. And this is indeed the ſole reaſon which forceth the Ocean Weſtward. The ſame thing is to be underſtood of the Winds; for what the Sea ſuffers, the ſuperincumbent Air feels the ſame.

Now this Motion of the Ocean, is not only the principal, but almoſt

the only cauſe of all the Tides of the Sea which do happen in all parts of the World, as ſhall manifeſtly appear from what ſhall be ſaid hereafter.

CHAP. II.

The Yearly Motion, which is the declination of this former Motion, is explained.

BEſides this Motion of the Sea and Winds, there is alſo another to be obſerved; which likewiſe does conſtantly attend the Sun. For as the Sun keeps not always to the ſame parallel, but declines ſometimes to the North, and ſometimes to the South; ſo in like manner the Current of the Sea is affected. When the Sun is in the Northern Signs, that general Motion likewiſe inclines Northward; and when the Sun returns to the Southern Signs, thitherward alſo follows the courſe of the Wa-

Waters, yet so still as the parts of the Ocean, which are directly under the Sun, keep always a strait course towards the West.

Let us take the Pacifick Sea for an Example: For those who plow that Ocean, and are bound from the Coast of *Peru* to the Westward, if the Sun be in the Equinoctial, in all the Sea which lies under the Torrid Zone, find the same Wind and Current, until that without any stop or impediment they are most securely conveyed to the *Molucca's*. But if the Sun be in the Northern Signs, thitherward likewise tends the course of the Sea and Winds. So that the Sun being in the Topick of Cancer, the Easterly Wind and Current is observed even to the Six and thirtieth Degree of North-Latitude, and farther. And they that sail in the Southern Hemisphere, are forced to approach to the Equator, that they may catch this Trade-Wind. But if the Sun be retreated to the Southern Signs, then the Current and Easterly

Winds reach as far as the Fourtieth Degree of South-Latitude: And on the other side, they who sail in the Northern Hemisphere, in this Pacifick Sea, are constrained to stand Southward, towards the Equator, that they may gain the Easterly Wind and Current. Neither in the state and condition of these Motions only so in the middle of the Pacifick Sea, but also in the extremities of it, to wit, at the *Molucca* and *Philipine* Islands the same course of the Floods and Winds is to be observed. Six whole months, from *March* to *October*, the Sea is droven to the North; but from *October* to *March* it takes its course Southward.

The same is the condition of the *Atlantick* Ocean; which though it tend always Westward, from the Coasts of *Africa*, yet the manner of its Latitude and Declination is not always the same. When the Sun is in the Summer Solstitial Circle, the Current and Easterly Wind comes much nearer to us. Upon the Coast of

of *America* it reacheth as far as *Cuba*, and the Bay of *Mexico*; and in the parts nearer to *Africa*, to the Eleventh or Twelfth degree of North-Latitude. But the Sun being in his Winter Solſtitial, that Current continues not beyond the Fourth Degree of North-Latitude. When at the ſame time it breaks out much farther towards the South, reaching to the Fortieth Degree of South-Latitude, and upwards. Now the reaſon of the greater Declination on the courſe of *Africa*, is manifeſt enough; for the Continent of *Africa*, which takes up a great part of the Torrid Zone, hinders the excurſion of the Ocean that way. And the Coaſt of *Guiney* ſtops the natural courſe of the waters that they cannot dilate themſelves towards the North. But in that ſpace which lies betwixt the more Weſtern parts of *Africa* and *Braſil*, where the Sea more largely opens it ſelf, there alſo the Current extends it ſelf farther. So that upon the Coaſt of *Braſil* it never fails; but that when the Sun is in the

Northern Signs the Current that washeth *Brasil*, obliquely tends towards the North. And when the Sun is in the Southern Sign, the course of the Sea and Winds obliquely tends Southward.

It remains that we should speak of the *Indian* Sea, being likewise under the Torrid Zone. And here also the same thing occurs; for in this Ocean from the 10*th* and 11*th* Degrees of South-Latitude to the 28*th*, and from the *Indian* Islands to the Coasts of *Africa*, and the Island of St. *Lawrence*, there is but only one constant motion of the Winds and Tides. Now when the Sun is in the Northern Circles, these Trade-Winds and Tides do stretch Ten or Eleven Degrees farther towards the North, until they reach the Æquator. And when the Southern Signs are by the Sun illuminated, according to declination, the Wind and Current decline likewise to the South. For then the motions of the Sea and Winds tending Westward, even to the 36 Degree of South Latitude, are every-where observed in this Sea. And

the

the same thing which we have said, does happen in the Sea at the *Philippine* Islands, and in the *Atlantick* Sea upon the Coast of *Brasil*, is likewise observable in the *Indian* or this Eastern Ocean. For immediately after the Vernal Æquinox, the heat scorching the Eastern Coasts of *Africa*, and the Streights which divide the Island of St. *Lawrence* from this Continent, the Waves are forced Northward. But the Sun being again returned beyond the Autumnal Æquinox, the Winds and Tides forthwith take their course towards the South.

Although from what we have spoken of the reason wherefore in the *Atlantick* Ocean the Trade-Wind and universal Current, which hurries the Sea Westward, does somewhat decline towards the South, it may be gathered why in the *Indian* Ocean the same Current does in like manner, and even sometimes more deflect from its natural course thitherward; yet because that cause alone is not sufficient, for the fuller understanding of this matter,

ter, there must of necessity be premised another notion of the Ocean; which being known, the demonstration of this secret will become plain and easie.

CHAP. III.

Of a third Motion contrary to the first.

THere is therefore, besides these genuine motions of the Sea that we have explained, a third also to be considered; which though it depend on, and be raised by the first motion, is nevertheless quite contrary thereto, as tending from West to East. For when these aforementioned motions do cease, then at length this begins; and as that general current inclines to the South or North, so does this likewise, begirding the same on each side, with a contrary motion or Tide Southward and Northward. This is the Current by the help of which Sea-

Seamen sail from West to East. For when in the middle of the World all Navigation Eastward (by reason of the Current which we have described) is obstructed; the more expert Mariners do stand so far South or North, until they meet with this Wind and Current. And therefore such as sail from the *Philippines* for the Coast of the Western *America*, leaving the Torrid Zone, stretch atwhart to the thirty-sixth or fourtieth Degree of Latitude; according as the Sun is more Southward or Northward, and there find a certain Wind and Current which may bring them to *Califurnia*. They who from the Bay of *Mexico*, *Florida*, *Virginia*, or the *Holland*, are bound for *Europe*, take the same course, and find the same Wind. They bear up to the thirty-third or thirty-fourth (at least) and in Summer to the fourtieth Degree of North-Latitude and upwards, that they may obtain a Wind still favourable. Those who sail in the *Atlantick* Sea, or are bound from *Brasil* to *Angola*, observe the same rule,

for

for when the Sun is in the Southern Signs, they are forced to ſtand off to the thirty-fifth or thirty-ſixth Degree of South-Latitude, where they meet with a Wind and Current that ſets conſtantly from the Weſt. But if the Sun be about the Tropick of Cancer, it is enough to have ſtood off to the twenty-ſixth or twenty-ſeaventh Degree of South-Latitude, until they come up with the Coaſt of *Africa*. When they are got thither, they find a favourable Wind and Current to *Angola*, and even farther. The ſame thing is alſo to be obſerved in the *Indian* Sea; for they who there make any Voyage to the Eaſtward, avoiding the middle Region of the Ocean, ſtand off to the North or South, beyond the bounds ſpoken of in the former Chapter, where they find a Gale perpetually blowing from the Weſt.

CHAP.

CHAP. IV.

The Cause of this Motion is explained.

THere may be a most certain reason given, why this motion of the Ocean goes in a course contrary to the first motion thereof. For when the Seas in the Torrid Zone do run perpetually from East to West, and never go back, that this Current may always continue, it is necessary that one of two things should happen, either that these Tracts of Land from whence the Waters begin to depart, should be left wholly bare, or that some succeeding Flood should fill up this vacuity. Now seeing the former is false, it follows that the other must be true, and that that diminution of Waters is made up by fresh Floods which on each side flow thither. But that this may be the more clearly understood, I think it will not be amiss, a little more fully to demonstrate

A A A A B B B B F F F F E E G G G G D D D D Q Q Q Q

ſtrate this courſe of waters by a dayly and every where obvious example. Suppoſe then A. B. C. D. to be a Channel or ſome ſmooth River, and therein let the Boat or ſhip E. be carried from F. toward G. although the cauſe, to to wit the Sun, which makes the Waters to ſwell, and the Boat which with it's ſtem drives forward and raiſes the Water toward G. be unlike, yet the effect is the ſame. Now ſeeing the waters do perpetually accompany the motion of the ſtem, and that the Waters not only from F., but alſo from B. and D. move towards G. it neceſſarily comes to paſs: that the level of the Waters in F. becomes more low and depreſſed, than in G. but becauſe the Waters move conſtantly from B. D. and eſpecially from F. towards G. and do not inſtantly flow back again, ſo that the ſurface of the Channel is rendred more low in F. therefore this loſs is made up by the Waters in A and C. even yet unmoved, which with great force fall down from a higher place into a lower. This

is manifestly found to be so by those who are carried in the Boat, or who look from the shore; for by how much the more narrow the Channel is, and the motion of the Boat swift, by so much the more the banks in A. and C. will be left naked, even before that the Boat arrive thither. But on the contrary behind the Boat in B. and D. so much higher the tide will appear, as the Ebb in A. and C. is the greater.

The reason is moreover clear wherefore the waters in A. and C. decrease sooner than they rise in B. and D.; because that the waters which are stirred by the Boat, and forced towards G. tend from a lower place over a setled surface, that is to say upwards, and therefore they move more slowly. But the Waters which flow back again from A. and C. have a swifter motion, because from a higher place they fall into a lower.

It is not to be looked upon as strange that two contrary motions meeting, the one does not choak and

stop

ſtop the other. For it is not the ſame caſe with fluid, as with ſolid bodies. If at both ends of any long kennel or pipe we let in water, in the place of their meeting we ſhall forthwith ſee, that the contrary Current is not vehemently choaked or diſſipated, but that the one Water does gently and without ſhedding glide under the other, and the motion continue until each have attained it's appointed limit. The ſame alſo happens when we throw two Stones into water at what competent diſtance ſoever, for the circles that are by that motion deſcribed mutually paſs under one another, without looſing their place or figure.

From hence alſo is clearly deduced the reaſon, why ſhips are carried more ſwiftly in the Sea than in Rivers or Channels, and in broad Channels, than narrow, where veſſels move moſt ſlowly. For in larger Channels the Waters which are forced forward, raiſe not high the ſurface of the Channel becauſe they have room to ſpread

themſelves. And the cavitys which are made behind are filled by the Water which from each ſide does gently and eaſily ſucceed into the place. But it is otherways in narrower Channels, where the Waters that are preſſed forward by the Stem by reaſon of the narrowneſs raiſe high the ſurface which they overflow, and on the contrary fall violently and from a height downward that they may fill up the Cavity left behind. And therefore ſeeing the Stem of the boat is raiſed and the ſtern depreſſed, it muſt neceſſarily be that it's progreſs ſhould proove heavy and ſlow. But if another Boat ſhould follow after, becauſe it did not aſcend but ſlide down into the Cavity of the more depreſſed Channel; it would without the help of any motive impulſe, of it's own accord deſcend and in ſome manner ſeem to ſtrike to the ſtern of the leading Boat.

If any one deſire an example whereby this flux and reflux of Waters may be more clearly demonſtrated, a Ditch

or

or River narrower than a laden Barge or Boat can be able to pass, may afford it him. For if the vessel draw deep and cannot find passage, and that nevertheless you would endeavour to make way for it; by this means it may be done. Take another boat less, or at least less laden, which may easily be advanced through the streights of the Channel. If you advance and cause this to go before, the Waters coming after must necessarily (as is clear from what hath been said) rise into an heap: wherein if you immediately make the other laden Boat which stuck before, follow after; it also finding a fuller and higher Channel, will make it's passage: and it will be more painful to bring forward the emptie Boat which goes before, than the laden which follows after, because this of it's own accord will follow the other.

Waters that from Cataracts, or through any streight passage do with swiftness fall into the Sea or any large Ditch or River, may afford an instance

no leſs clear and conſpicuous of this contrary motion. The middle Channel and theſe Waters which in a ſtreight line are forced forward by the entering ſtreams, even to the eye keep a ſtreight courſe. But the Waters on each ſide adjacent, though by the ſame motion they be affected, do not immediately accompany the middle ſtream, but flow back and whirl round in a circle. And if they be near the middle Current, after a little turning, they fall into it again: But if they be farther off, they make larger circles or whirlings, until they return almoſt to the firſt Fall; and ſo at length either begin a new whirling; or with the other waters falling from the Cataract, march ſtreight forward.

CHAP.

CHAP. V.

In what manner the Level or Balance of all Seas by the foresaid motion is restored.

SInce from what we have before discourſed of, (if I be not miſtaken) a two fold flowing of the Sea may be plainly enough underſtood, which with a contrary tide hems in the middle Current of the Ocean, that perpetually tends Weſtward; it follows in order that we explain the way and method obſerved by nature, for the continual preſerving of the ſame balance and level of the Seas, leaſt whilſt the Current flows Weſtward, the Seas ſhould either retire back or the ſhoares be left dry. If the whole World were every were covered with waters, ſo that no land appeared and that the Sun never declined towards the South, or North, but kept himſelf always in the ſame circle; the face of the Seas

would be always one and the same; the middle tract of the Ocean would continually roul Westward, and the Floods on either side succeeding would compensate this retreat of the Waters. But since that there occurrs many impediments of land, and that the aspect of the Sun varies, it cannot otherways be, but that different and various motions of the Sea should from thence arise. Now that it may appear that these motions (however unlike) do by reason of the approach of the Sun, and the nature and figure of the Shores observe a like order, it will be necessary to illustrate what alterations the Ocean undergoes in the several parts thereof.

We must therefore know that although the lateral and succeeding floods do again recruit the depressed and lower level of the Sea, from which the Sun is fartheſt retired; yet this motion is more conspicuous and violent upon the shoars from which the Seas do ebb, than in the middle regi-

on

on of the Ocean, where a more abundant store of waters is at hand. Let us first take notice of the Pacifick Sea; which ebbing from the coasts of *Peru*, *Nicaragua*, and New *Spain*, lest that the Shoar should be left bare, receives a double flood; one which sets from the North, and the other from the South. The Tide which makes from the North is always one and the same from *Califarnia* to *Nicaragua*, the contrary to this which is likewise always constant, is the Current which washeth the Shore of the Kingdom of *Chile* and *Peru*, setting from the South always Northward as far as the Countrey and River of *Tombes*. Therefore upon all the *Peruvian* Coast there blows only a South wind; and there is only one Current or tide which from South sets always Northward, in the middle distance which reacheth from the River *Tombes* and the Island *Puna* to *Nicaragua*, according as the Sun is more Northerly or Southerly, so likewise the Floods (after the manner above declared) direct their course South-

ward

ward or Northward. Now wheresoever these two Currents from North and South do meet, they choak not one another and make an eddy, but are carried away by the general Current; so that all their flores being joyned they are hurried in company together towards the West.

Now let us examine the Current and Tides on the coast of *Affrica*. When therefore the Seas do ebb from the Shores of *Angola* and *Congo*, lest that here also the land and bottom of the Sea should be left dry, they are by a Two-fold Flood supplied. The Current which flows from the North, comes from the Atlantick Shoar and *Canary* Islands and passing first by *Cape Blanco*, next *Cape de Terd* and then the following Promontories, until it reach the coast of *Guynnee*, in a narrow Channel with a most rapid course it scuds along all that Tract of *Affrica* which from *Guinee* expands as far as the Island of *Ferdinand Poo*; from hence it tends to thePromontory of *Lope Gonsalvo*, and in the Winter

even

even four or five degrees beyond it. Afterward leaving that Shoar it follows the universal current, and takeing it's course contrary to what a little before it had, by how much more rapidly it hastens Westward, so much more water it attracts and continually sucks through that narrow Channel which we have before described.

The other motion of the Sea upon the same coast of *Affrica*, which we said did compensate that retreat of the Floods to the middle Current of the Ocean, sets from the South, and from the *Cape of good hope*, reacheth to *Angola*, and the *Cape lope Gonsalvo* or somewhat shorter.

Wherefore such as are bound from *Europe* to *Angola*, are forced to bear off to the Island of *Martin Vaz*; and then (as we said before) stand Southward to the Southern Ocean. From thence they take their course Eastward, and having sailed Fifty *German* Leagues or more, they steer towards

towards the Coast of *Affrica*, where avoiding some Shelves upon the Southern Coast of the Kingdom of *Cimbeba*, at the 20, or 21 Degree of South Latitude, they bear in again to the Shore; and from thence with a favourable Wind and Current in a very short space are carried to *Cape Negro*, then to *Angola*, and afterwards to *Cape Lope Gonsalvo*.

Moreover both these currents of the Seas do meet at *Cape Gonsalvo*, or (as we said) four Degrees more Southerly, and there joyning their forces tend Westward, and accompany the universal current of the Ocean.

But before we proceed farther, it will be very necessary to observe wherefore and when it is that the aforesaid current on the Coast of *Guynnee* happens in a contrary manner, lest that if we should pass by this disagreement, some may perhaps suspect the verity and reasonableness of what we write.

Therefore though no body who hath

hath any experience, can be ignorant of what we are about to say, nevertheless order requires that we should give notice; that in all that Zone which we call the Torrid, and which lyes betwixt the two Tropicks, the seasons of the year are quite contrary, to what they are with us, or our *Antipodes*. For when the Sun being neareſt to us makes Summer, and remoteſt from us, Winter; the contrary happens to them who any where inhabit the Torrid Zone, unleſs the mountains hinder. When the Sun removes from them, they feel greateſt heat and faireſt weather: but when the Sun is neareſt, and right over head, then have they cold and rain, and therefore they call that ſeaſon Winter and the other Summer. So that when the Sun moves in the Northern Signs, they who live in *Guynnee* and the nearer Coaſts of *Affrica*, have their Winter; then are never or very rarely, any Land Winds obſerved on that Sea; for they are quaſhed by the Sea-Winds which conſtantly

blow

blow from West or South-west.

The Sea likewise as we have said during that space, moves perpetually from West to East. But, in the Month of *September*, when the Sun declines towards the Southern Signs, then do the cold and rains by little and little abate; and the following Months (with them) are serene and fair, especially *December* and *January*, wherein they endure the greatest heat: and then also the Sun being most remote, the Land-Wind especially that which they call [*Herman*] blowing from the Northeast, begins to prevail. Yet this does not constantly blow, but for the most part from the Afternoon untill Midnight. It blows three or four days at least, and sometimes a Fortnight, but very seldom lasts longer. Then also that current of the Sea whereof we have spoken, is altered, for the Tide then sets rapidly Westward. Yet as the course of the Wind is not here always constant, so neither the current of the Sea; for it is now and

then

then interupted and driven backward by a contrary Wind and Tide, so that they who in that season lanch along that Shore, dare seldom trust themselves to this inconstant and treacherous Wind and Current. During the three following Months, to wit *March*, *April*, and *May*, the Land and Sea-Winds blow by turns. But although they blow hard, yet are they not always too strong for the Tide, though sometimes they retard and keep it in suspence. In *June* at length the Land-winds cease, and then return the West and Southwest Winds which blow constantly until *December*: for the Sun at that time (according as we have said) approaching nearer, and forcing the neighbouring parts of the Ocean Westward, does necessarily streighten into a narrower compass than that Channel which washeth the Coast of *Guynee*, and perpetually supplies the ebbing of the Waters. Now these Waters being so contracted do more swiftly blow Eastward, and therefore easy.

eafily beat back whatſoever Winds can blow from the Land.

But the Sun departing again towards the South, becauſe that then alſo the current of the Waters Weſtward does decline, it is neceſſary that theſe ſubſidiary and reſtoring Floods, ſpreading themſelves into a larger ſpace, ſhould therefore move more ſlowly towards the Eaſt, and by reaſon thereof have leſs force to reſiſt the land Breeſes. But that theſe things may be the more clearly and certainly underſtood, we ſhall farther alſo examine the motion of the *Indian* Ocean.

We have ſaid that this primary motion of the *Indian* Ocean, to wit that which conſtantly waits on the Sun, and is the chief and almoſt the ſole cauſe of all the Tides of the Seas, is limited betwixt the Equinoctial Line and the thirty ſixth Degree of South Latitude. We have likewiſe taken notice of the Summer and Winter Declinations; For the Sun being in the Southern Signs, this

Current

Current reacheth not beyond the tenth or eleventh Degree of South Latitude. But when he approacheth to the Tropick of *Cancer*, we told you that this Sun-attending motion is not obſerved beyond the Equator. Now the reaſon why this Current is not obſerved farther is to be taken from the ſcituation of the Land. For when the *Indian* Sea upon that ſide which reacheth to the North, is every where encompaſſed with Land, and receives no other Northern Ocean, as the *Pacifick* and *Atlantick* Seas do, it is no wonder that if there be leſs ſtore of Water to ſucceed into the place of the receding ebbe, the breadth of that middle Channel ſetting Weſtward ſhould be leſs and more contracted. If there were no Land which from the North did hinder, then would this Sun-following Current ſpread it ſelf into the ſame breadth in the *Indian* Ocean, as it does in the *Pacifick* and *Atlantick* Seas, and would reach to the Tropick of *Cancer*, and farther.

But now since the *Indian* Sea from the North is by the shores of *Affrica*, *Asia* and the adjacent Islands, shut up on every side (as it were) in a Bay, reason it self requires that a Sea thus hedged in on every hand, and receiving no other Seas but through the little streights of Islands, should either not move at all, or at least but slowly and with difficulty, and that the ebbing of the waters should be proportionable to the Flood. When therefore the Sun visits the Southern Signes, that current of the Sea tending Westward ceaseth in all the *Indian* Ocean even to the tenth and eleventh Degree of South Latitude, and at length beyond the South Coast of the Island of *Java*, it is again perceived.

But when the Sun hath surpassed the Equator, and does more vigorously display his force in the Northern Hemisphere, then does that Westeren Current dilate it self as far as the Equator; and then also come flowing from the South Sea,

sup-

ſupplies to make up its ebbs. From the North alſo there comes ſucceedaneous floods, which behind ſupply this retreat of the waters, without leaving the *Indian* Shores naked, or diminiſhing the Northern parts of the Ocean. For the Sea flowing from the Eaſt, and ſetting towards the Eaſtern Coaſt of *Affrica*, having reached and paſſed the Northermoſt Cape of the Iſland of *St. Lawrence*, it beats not upon the Shore, or rebounds, but turns aſide firſt Northweſt, then North, and laſtly Northeaſt. For firſt it paſſeth the ſucceeding Coaſts of *Affrica* as far as *Cape Guardafuy*, next of *Arabia*, and then in order it waſheth all the Shores of *India*, and thus makes up by degrees whereof we have ſpoken, ſo that the ballance and level of the Seas remains ſtill the ſame.

Moreover, the ſeaſons of the Year, obſerve the ſame rule and time on the Coaſts of *India*, which we mentioned to be upon the Shores of *Guynnee*. When the Sun makes his

greſs towards the Northern Hemiſphere; and when the recurrent Tides and Winds whereof we have diſcourſed, do ſet from the Coaſts of the *Affricans* and *Ethiopians* towards the Shores of the *Arabians* and *Indians*, then is it Winter in all that Ocean, and in the Countreys ſcituated betwixt the Tropick of Cancer and the Equator. For whereſoever theſe Weſt or South-weſt Winds prevail, there cold and rains do abound, which begin about the end of *April* and leave off in *September*, there is it then Winter; but Summer begins with them after *September*, and ends in *April*: and ſo in *December* and *January* they have a moſt ſcorching Summer. Then likewiſe blow the Land-winds from Eaſt and North-Eaſt, but not conſtantly, only from Midnight to Noon, for from Noon again till Midnight the South and South-weſt Winds return, which blow all the Sea over, when theſe other Land-Winds that we have been ſpeaking of are not

per-

perceived above ten leagues out at Sea.

Although this that we say be generally and for the most part true, that within the Tropicks the Western Winds and Currents bring Winter, and the Eastern, Summer; in these places nevertheless were very high and lofty Mountains do interpose, it is quite otherways. When therefore in that *Peninsul* or neck of Land of *India*, where *Goa* and the *Kingdom* of *Malabar* do lye, on the one side it is Winter, in the opposit side they have Summer. For when the Western Wind which brings rain and cold to the People of *Goa* and *Malabar*, cannot surmount the Hill *Gates or Ogates*, which divides all the *Peninsul*, it must of necessity either turn aside or be reverberated, whereby Thunders and fearful Storms are occasioned. When at the same time in the Kingdom of *Coromandel*, so near them; it is not only calm, but fair and serene Summer weather.

The very same happens at *Guardafu* which is the Eastermost *Cape* of all *Africa*, and also at *Posalgate* likewise the Eastermost promontory of *Arabia*. For because in both these places vast mountains do rise; therefore after the same manner the changes of the year and air are regulated. There, Summer and Winter are only distinguished by the tops of the Hills. They who sail in these Seas do so suddenly find that diversity of Wind and Tide, that men in one and the same Ship do often see the fore sail filled with one wind, and the main sail with a contrary. To conclude, this is not only to be observed there, but every where also in these parts about the Tropicks, where high mountains do streatch from North to South.

CHAP.

CHAP. VI.

That all the Waters of the Ocean turn round in a Circle, and return to the same point from whence they departed.

WE have said enough (if I mistake it not) of the Motion of the Ocean within the Tropicks, as also of the other Motion which does on each side begird that Current. Now let us consider after what manner the Seas are affected when they are more distant from that Sun-following motion, from the which we have asserted, that all the other Tides and Motions do depend. Let us take notice of that Sea, which whether we call it the Atlantick Ocean, or by any other name, is all that Sea that lyes betwixt *America*, *Africa* and *Europe*. We have told you that the middle or Sun-attending Current thereof is continually hurried from the Coast of *Africa* towards *Brasil*,

and the more Northern parts of *America*. When it arrives there it does not recoile, but parting two ways, runneth partly towards the South and partly Northwards. And if the Sun move in the Southern signes, it declines to the South or Southwest; but if in the Northern signes he have his course, then in a full body it hasttens Northward, washing first the North-side of *Brasil*, and then the succeeding Coasts of *Guaina*, until it come to the *Isthmus* and *Bay* of *Mexico*; from whence again turning sideways, it passeth the *Bahamean* Streights or Gulph of *Florida* with a violent Current, and partly glides along *Florida*, *Virginia*, and all the Northern Coasts of *America*, partly it sets due East, until that it beat the opposit Shoars of *Europe* and *Africa*, and from thence again it incines to the South; and in that manner as we said before falls into the primary Current; and so is whirled about perpetually in a Circle.

If therefore in the beginning of the Spring

Spring, a Ship ſhould put out from *Europe*, ſuppoſe from the French Sea, which borders on *Spain*, it is poſſible that without the uſe of any Sails, with a proſperous Wind and Current ſhe might make four thouſand German Leagues, and at length return to the ſame place from whence ſhe ſet out. For in the firſt place ſhe would be carried to the *Canary* Iſlands and Weſtern Coaſt of *Affrica*. And from thence having paſt *Cape Blanco*, *Cape Verd*, and the *Cape* called *Lions Cape* would fall down upon the Coaſt of *Guynee*, and ſo forward to the *Cape Lope Gonſalvo*, or a little farther. From whence ſhe would again change her courſe and ſtand for *Braſil*. Now if ſhe ſhould hit upon the Southern Coaſts thereof, ſhe would fall to the South, and by the South Sea be carried Eaſtward. But if ſhe ſhould be driven upon the Shores of *Braſil* ſomewhat more northerly, ſhe would follow the Current which we have deſcribed, and having paſt all that Sea which reacheth to the *Bay* of *Mexico*, would

would through the Gulph of *Florida* or *Bahamean* Streights, again return towards the Coaſt of *Europe* until that ſhe ſhould abſolve her whole Circuit.

And this is truly the revolution of our Seas: It is the ſame in the *Pacifick* and *Indian* Oceans, and that by vertue of the Currents and Tides which we have explained, which unleſs they turned circularly round, the Seas muſt every where reſt without motion. And from this is manifeſt wherefore *Mediterranian* Seas, and ſuch eſpecially which are moſt diſtant from the courſe of the Sun, have not any, or but very ſmall Tides.

Now although that this Circulation of the Seas would be more diſcernable if the Shores of the land lay equally round in a Circle, yet notwithſtanding that this is not ſo, theſe motions of the Sea do ſo clearly appear, that whatſoever happens in a Circle, the ebbing and flowing, or the courſe and recourſe of the Seas ſuffers the ſame. For as the oppoſit parts of a Circle

are

are carried always by a contrary motion, the same is likewise to be seen in the Ocean. When the Sea that is between the *Tropicks* is driven from East to West, then the Seas that are near us, and parallel to it, return from the West to East; when the Sea that washeth the Eastern coast of *Brasil* sets from North to South, then the Seas that are opposit thereto upon the Coasts of *Cinbeba*, *Congo* and *Angola*, flow from South to North. When the Sea which passeth along the North side of *Brasil*, *Guiana*, *Venezvela*, *Honduras*, *and Jucatania* is hurried from East to West, then the Sea which beats the Coasts of *Guynee* and *Benin* runs from West to East. When the Sea at *Honduras* and *Jucatania* stretches towards the *Bahamean* streights, *Florida* and *Virginia*, from South to North, then likewise the Sea on the opposit Coast of *Affrica*, which reacheth from the streights of *Gibralter* to the land of *Negroes* or *Guynnee* flows from North to South.

And

And this Course of the Ocean is perpetual whilst the Sun does illustrate the Northern signs. But when he hath taken his progress to cherish the Southern constellations; though that on the above mentioned Coasts the course of the Ocean either ceaseth, or is carried by a contrary motion; yet the same rule of circulation always remaineth. For because that then in the streights of *Baham* a or *Gulph* of *Florida* and upon the Coasts of *Mexico* and *Honduras* the Sea setteth from North to South; so likewise on the opposit Coasts of *Affrica* which reacheth from *Cape de Verd* to the streights of *Gibralter*, there is found a contrary Current setting from South to North. When from *Hordunaras* the Sea flowes to the Eastmost *Cape* of *Brasil* from West to East; then also for the most part, the Sea which plays upon the Shores of *Benin* and *Guynnee*, runs from East to West: and so of the rest.

Now there can be no other reason given wherefore this current and

Tide

Tide is not in all places equally conſpicuous, but the unequality of Channels through which the Ocean flows. For the very nature of things requires, that where the Channel and paſſage is narrower, there the courſe of the Waters ſhould be ſwifter. And the ſame proportion that one Channel beareth to another, the ſwiftneſs of the Streams that paſs through the ſame, have likewiſe to one another.

Nevertheleſs I will not deny but that this order of nature is ſometimes interrupted and diſturbed by the Land winds, and ſuch as ſeem caſually to ariſe; but it is enough for us to have explained a general motion, ſo uniform and conſtant to itſelf that if it happen to be diſturbed, it is only at ſome certain and fixed ſeaſons. Neither in the Ocean alone but in the remote Bay's and Inlets of Seas, the ſame is the reaſon and manner of Tides; for every where the Floods turn and whirle round in a circle. In the *Adriatick* Sea the Waters move along the Shores of *Dalmatia* and

Croatia

Croatia, even to the bottom of the Gulph of *Venice*. From thence by a contrary motion they wash the coast of *Italy* until they return to the place from whence they came. Neither does it happen so only in the *Adriatick*, but likewise in all the *Mediterranean* Sea. For although the Currents of this Sea are not so discernable as the course of the Ocean, and that the Tides in many places are scarcely sensible, and are often intercepted by Land Winds; yet here also the case and manner of the Currents are found to be the same. Upon the Coast of *Mauritania* and *Numidia* the Seas flow from West to East, by reason of the entrance of the Ocean which in that place is contrary to the course of the Sun; as we have already made appear. But on the contrary on the opposit Coasts of *Italy*, *France* and *Spain* the Tides and Current set from East to West until they come to the *Streights* mouth where they meet the Ocean and there part of their Waters set outward; but the

rest

reſt being repulſed bear down upon *Mauritania* & the ſucceeding Coaſts, till by the force of the Ocean they accompliſh their full circuit.

The ſame thing is alſo to be ſeen in the Eaſtern parts of the *Mediterranian* Sea, where it beats upon *Syria* and *Egypt*; for there alſo the floods wheele about in a circle though after another manner; the nature and conſtitution of the Sea it ſelf ſo requiring. Although the *Mediterranean* Sea be ſeperated from the Ocean, and at a diſtance from the Torrid Zone, yet it is obnoxious to the ſame motions though ſmaller. For ſeeing it is not ſo far diſtant from the courſe of the Sun; as either the *Archipelage*, *Euxine*, *Caſpian* or *Baltick* Seas, and reacheth a great deal farther from Eaſt to Weſt; it is not to be thought ſtrange that when the above named Seas ſwell not with any ſenſible Tide; this ſhould ſuffer at leaſt ſome alteration from the vicinity of the Sun. It hath therefore a Current from Eaſt to Weſt, and although that flood be not

not very conſpicuous, it may be nevertheleſs gathered from this, that Ships ſailing from *Syria* and *Egypt*, do ſomewhat ſooner arrive at the *Streights* mouth, than ſuch as ſet out from thence can get to *Syria*. This Voyage would likewiſe be ſooner performed, if upon the Coaſts of *Numidia* and *Mauritania* they did not meet with the flood of the Ocean which retardes their courſe. Hence it is manifeſt that the Current and Tide of the Weſtern parts of the *Mediterranean* Sea is guided by the Ocean, and by it forced round in a Circle; but the Eaſtern part of the ſame, where the Ocean never or but very ſeldom reacheth in its courſe follows the Motion of the Sun; now though this Motion be contrary to the former, yet the ſame is the reaſon and manner of Circulation in both. The *Egyptian* Sea, for the moſt part ſetteth from Eaſt to Weſt, and the *Pamphylian* on the other hand from Weſt to Eaſt. The *Ægean* Sea in that part thereof which waſheth *Aſia*

flowes

flows from North to *South*. But where it Beats *Macedonia* and *Thracia* it runs from *South* to North.

To conclude if we consider the *Seas* all the World over, unless they be such as utterly deny entrance to the Currents of the Ocean, or are not too far distant from the *Sun*, we shall every where find the same manner of revolution. In this our narrow *Sea* upon the coast of *Holland* the set of the Tide is from *South*-West to North; when on the opposit shoar of *Britan* the Motion is contrary to wit from North to *South*. The same is also to be observed in the Gulphs & Bay's of the Ocean, as in the *Persian*, *Arabian* and other lesser. And even the entrance and larger mouths of Rivers, as of the *Maese*, *Sein*, *Garon*, and of an infinite number of others, undergo the same vicissitude.

CHAP. VII.

After what manner the Sea moves in Friths *and* Streights.

IT is not our design to enumerate all the Friths and *Streights* of the innabited World, and the anniversary Winds and Tides which at set seasons do in the several Channels of the Ocean recur; it shall suffice to advertise that if the Motions which we have already explained be well observed, it will be no hard matter to infer, what Tides and Winds in the several seasons of the year do predominate in every Frith.

If any be desirous to know what is the Current of the *Sea* at the *Streights* of *Gibraltar*, whereof we discoursed a little before, he may easily come to know it from the Motion of the Ocean, which all the World over, at the same distance from the Equator moves contrary to the *Sun*. Through these *Streights* the

Sea

Sea flowes almoſt conſtantly Eaſtward, eſpecially upon the Coaſt of *Mauratania*, and ſcarcely is this Current the fourth or fifth part of time diſcontinued by a contrary motion. For in the ſpace of a day and night the *Seas* ſet outward five or at moſt ſix houres, but inwards eighteen. Neither for this muſt we imagine that the *Mediterranean Sea* ſhould ſhortly ſwell to a vaſt bigneſs, becauſe that the Ocean does for ſo long a time ſet inwards, and has but ſo little ſpace to ebb again. For Nature her ſelf has provided againſt this; ſeeing in that part of the *Streights* which lyes upon the *Spaniſh Shoare*, the courſe of the waters is for the moſt part contrary. There the ebb laſts eight houres, and the flood only four, and by this means the ballance of both *Seas* is adjuſted. The ſame is almoſt the nature of the Channel that lyes betwixt *France*, and *Britain*. For here alſo thoſe that are inward bound find a quicker paſſage, than they who from hence put out to *Sea*.

If any ſhould go into the temperate Zone of the *Southern* Hemiſphere, he would find there the ſame thing alſo true. Let us take the *Streights* of *Magellan* for an Inſtance. *Seamen* avoid this a place moſt difficult and dangeroes to be ſailed in, becauſe there is reported to be an eddy there of two Oceans meeting, which raiſes fearful ſtorms. But they who think ſo, are ignorant of the nature of Waters. For the concourſe of *Seas* produceth rather a Calm than a *Storm*. Waters meeting with Waters claſh not together like *Solid* Bodies, but without quarreling the one yeilds and ſubmits to the other, and fairly mingle together without any noiſe; ſo that we may ſee two Mountains of Waters meet one another not only without breakes, but even ſmoothing the ſurface of the *Sea*, the reaſon of the equality of ballance ſo requiring. But that I may return to the *Streights* of *Magellan*, it is for another reaſon, that they who have ſhot the the ſame, have encountered with ſo great difficulty

culty in their undertaking; for they have had the Current of the *Sea* to ſtrive againſt, which, unleſs it be by the land Winds hindred, ſets there always againſt the courſe of the *Sun*. There is but one Tide or Current in all theſe *Streights*, which is occaſioned by the *Pacifick* commonly called *Mar-del Zud* or the *South Sea*. This Current is moſt rapid in the Weſtern part of the Frith; and eſpecially in that narrow paſſage that is diſtant about thirty Leagues from the Weſtern mouth of the *Streights*. The Eaſtern part of the Frith which piece and piece does open wider, to the breadth of ſeventy Leagues, although it be alſo affected with this Current, yet it's motion is more ſlow and dull, both becauſe that by reaſon of the diſtance, the Current arrives more ſlowly; as alſo that in a wider Channel the Waters looſe their rapidity, and indeed ſo much, that by land or fortuitous Winds their courſe is often repelled. Therefore it is not ſtrange that they who entred theſe

Streights on the East side have endured great work and toil. When as *Peter Sarmien*, who from the West past through the same and returned to his Consorts, easily and without any trouble performed it.

The same is altogether the condition of the Currents and Tides which occur in the Streights of the middle Zone, except, that according to the several seasons and situation of the Shores, they undergo diverse, yet set courses and recourses or ebbings and flowiugs. When the Sun is in the Northern signes, the Frith which divides *Samatra* from *Malacca* flowes South-East to North-West: but being again retreated to the Southern, the Current sets back from North-West to South-East. What are the Currents of these other Streights which separate *Samatra* from *Java*, may be easily understood from what we have said of the Indian Ocean. For in the Summer time, that is from the end of *April*, to the beginning of *October*, whilst the Ocean sets from East to West,

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it is hard to enter this Frith. But for those who from the DutchColony are then homeward bound, the passage is easy and commodious. And again from *November* until the end of *March*, the entrance of this Frith is easy for such as come from the West. But on the other hand they who at that time sail from the Dutch Colony Westward, have much ado to shoot it. So that if their occasions do necessitate them, they are forced to sail round all the Island of *Java*. First they coast along the Northern *S*hore of this Island, then pass the *S*treights, which divide the Island *Balo* from the *Cape Palimboa*; and afterward pass along the *S*outhern *S*hore, so that sometimes with greater ease they run above three hundred Leagues, than they can pass that Frith, which in other seasons of the year they may in a few houres performe. And it is by the help of the daily Tide of six houres, that Fleets (notwithstanding this yearly Current) do in all *S*easons of the year pass the *S*treights back and fore.

CHAP. VIII.

That the dayly Tide and Motion of the Ocean is regulated by the universal Currant.

SEeing it is not only useful but even necessary for Navigatiors to know from what point of the compass towards the several *S*hores and Tracts of Land the daily Tides do set, which in the space of twenty four hours do flow twice, and as often ebb; we must not pass over the general rule to which these particular motions ought to be referred: for we must know that all the world over the diurnal Tides do follow the universal Currents of the Ocean whereof we have discoursed. On the Shores which receive the *S*un-following Current of the *S*eas, as of *Brasil*, *Guiana* of the Island of *Madagascur* or *St. Laurence*, and many others the daily Tide sets likewise from East to West. The Northern Shores of *America*

merica that lye oppoſit to *Europe* have their Tide from *South* to *South*-weſt, according as they are more or leſs bent and crooked. The *Shores* of *Europe* that lye open to the Ocean receive their Tide from the Weſt, becauſe the Current of the *Sea* is ſo likewiſe. The Coaſts of *Guynnee* and *Benin* have alſo their Tides from Weſt. But in all the Coaſt of *Affrica* which reacheth almoſt from *Cape Gonſalvo* to the *Cape of good hope*, the diurnal Tide ſets from *South*. The ſame happens on the *Shores* of *Chile* and *Peru* for there likewiſe the Tides come from the *South*. Laſtly in the moſt Northern parts upon the *Shores* of *Spitsberg*, *Greenland* &c. When the Current of the Ocean beats the land, then likewiſe the daily Tides flow thitherward. And if it happen that the univerſal Current alter, then likewiſe the daily Tides are changed. So that upon the Coaſt of *Norway* in one part of the year the Tides ſet toward, and in the other from the *Shore*. Nor is the

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caſe otherwayes in the *Seas* of *India* and *China* at *Goa* and *Cochin*, when the *Sun* is in the Eſtival ſignes, the Tides ſet into the *Shore*. And being again in his *Southern* declination, they flow from the land. At *Tunchin*, and the *Southren* Coaſts of *China* during the ſix *Summer* months the Tides with the whole Ocean are hurried Northward. But the *Sun* again returning to the *South*, thither likewiſe, the daily Tides betake themſelves. In a word in all the places of the World the diurnal Tides conform themſelves to the above mentioned univerſal Currents of the Ocean.

CHAP.

CHAP. IX.

What is the reaſon that in many places the flowing and ebbing of the Ocean keep not equal time.

ALthough it hath appeared to many a very hard queſtion, why it happeneth that in ſome Friths and Channels and eſpecially in the mouths of Rivers, the Sea in it's flowing and ebbing does not obſerve an equal time, yet they who have treated of this ſubject, might have eaſily cleared themſelves of this doubt, if they had more throughly ſearched into the nature of an equipoiſe and ballance, and the hiſtory of the Motions and Currents of the Ocean.

Now as concerning the ballance or level of Waters, reaſon it ſelf does dictate to us, that by how much the greater is the ſwelling, by ſo much is the declivity greater, and by how much more is the declivity or deſcent, by ſo much muſt the Motion downward.

ward be more violent. Now seeing a swifter motion overwhelms a slower and weaker, it is manifest that if two floods of Water meet, the Current which falls from the greater height will be more sensible and conspicuous. So that the Current of Rivers being always downward, when the Tides of the Seas do every six houres either rise or fall; the very necessity of a ballance requires that the course of Rivers should be sometime accelerated, to wit when the Seas fall, and sometime retarded or driven back, when the Tide again in is it's height. But the Seas swell not every where in the same measure, seeing in some places they rise not above three or four feet, when in others they mount above sixty, so that according to the diversity of Floods and the Tides of places, they rise sometimes ten, and sometimes hardly one Foot higher: it is therefore consonant to the law of Nature, that the Current of Rivers should now sooner, now later be stopt or driven back. Wherefore if

there

there be any River which runs so softly that the least flood of the Sea may stop or make it recoile, in it the flowing and ebbing will prove equal. But if it require an hour before that the Sea flood can conquer the Current of the River, then will the Tide flow five houres or somewhat less, and ebb seven. And if the level of the Sea exceed not the level of the River, till after two houres be expired, then will the Sea flow only four houres, and ebb eight. And so of others.

Now if any one understand aright these motions and Currents of the Ocean whereof we have been discoursing. And know what shores are beaten by a direct, and what by an oblique Flood, he may easily know, in what part of the World the intervals of ebbing and flowing, are longer or shorter. It is to be observed therefore that in most part of Friths and mouths of Rivers, to which the Ocean tends only with an oblique Current, the Floods are shorter and the ebbs longer. In the mouths of

the

the Rivers *Niger*, and *Zenega* the Sea flows only four houres, and ebbs eight. The same happens also in the River of *Canada*, in the *Maese*, and almost in the mouths of all those Rivers, which the Ocean passeth with a transverse Current. It is every where remarkable that those Sea-floods which set obliquely into the Shore loose some part of their time by the force of the decurrent streams.

But on the other hand these Friths and mouths of Rivers to which the Ocean sets with a streight & headlong course, endure a contrary vicissitude. For whersoever the Sea with an entire Flood of Waters gorging the Shores and Jaws of Rivers, makes that the obvious streams must of necessity be repulsed and driven back, it cannot otherways be but that there the Tide of flood should be longer by how much longer the course of the Rivers is forced back. For in the River *Garon* the Sea flows seven houres and ebbs but five. At the town of *Macao* the flood lasts full eight or nine houres, and the

ebb

ebb but three. The same is to be seen on one side of the *Streights* of *Gibraltar* and in many other Friths and Rivers.

And this I would have understood only of the mouths of Rivers. For if such be the situation of Rivers, that with open mouths they receive, and convey far up the Sea flood, then the condition of the mouths and of these places of the Rivers that are at a great distance from the Sea, will be altogether different. For experience teacheth us that Tides which run far into the land & resist the Current of Rivers, do more slowly advance, than retreat, so that in the space of three or four houres they cast out as much water, as in eight or nine before they have drank up. Moreover this difference and inequality of the flowing and ebbing of Tides hath not only been observed in Friths and Rivers but also long ago on open Shores as is clear from *Bede*, and from the Book of the wonders of Holy Scripture, which is falsly attributed to *Austin*, seeing

it

it was compiled by an Engliſh man not unlearned, in the year of God D.C.L.X. They call thoſe leſſer Tides which at quarter Moon obſerve an equal ſpace of ebbing and flowing Nep Tides; but the greater floods that happen at the new and full Moon they call Spring Tides, which as they ſay flow five houres and ebb ſeven. The Tides alſo at *Cambaja* and *Martabano* are at their full in leſs ſpace. But of theſe hereafter.

CHAP. X.

From whence ariſes the difficulty which Navigators find in paſſing the Equator.

FRom what hath been ſaid it is manifeſt enough that the middle region of the Ocean which lyes under the Torrid Zone does ſwell more than the other Seas, at leaſt if we conſider that primary ſwelling, and not the other which the oblique Current

rent of Waters raiſes on the Shores, though if we would ſpeak properly, that is not to be called a ſwelling, but a progreſſive and regreſſive motion. Moſt part of Sailers acknowledg this ſwelling of Waters to be in the Torrid Zone, when they ſay they meet with as great difficulty in paſſing of the Line, as if they were to mount ſome Hill. Now if that heap and ridg of Waters did only begin, where that difficulty of advancing forward occurrs, then would it be eaſy to return back again, which is not ſo. There are ſome who to ſolve this difficulty, think that the ſurface of the Ocean is more depreſſed and low under the Line, and that Ships who get thither, fall down as into a hollow place or cavity, and therefore have much ado to come out again. But this is no better conſequence, than if one ſhould argue that becauſe Boats and other Bodies which ſwim in ſwift Rivers, keep always the middle of the Channel and can hardly be forced toward the brinks, the level of Rivers is lower

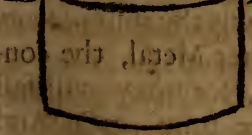
there than at the sides. Now it is impossible that in the middle where the Streams are crowded together, Rivers should be lowest. We must therefore find out some other reason to demonstrate the truth of this thing.

The case is thus then; they who from our Seas are bound to the Southward of the line, when they once get into the Torrid Zone, they are easily and as of their own accord carried to the Line. But when they come thither, they find that their ships cannot or very hardly either get back or fore. And it is evident that it is not the Trade-wind and Current setting Westward that hurries them along with it, because that when under the Equator they have a great calm; nevertheless the same difficulty happens so that sometimes they are three or four months time before they can clear themselves from this trouble. If in that place there were a perpetual Calm without being ever interrupted by any Winds, it would prove a fatal

Sea

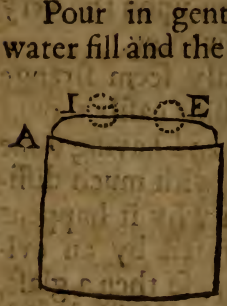
Sea to Sea men. So now (if I am not mistaken) it clearly appears that this swelling under the Torrid Zone, does not there begin where they find the difficulty of passing the line, but that ships when they are advanced to that place where they can neither get back nor fore, are then upon the very top or ridg of the swelling.

It will undoubtedly seem strange how it can be that ships easily mount a height of Waters, and having done so, get down again with much difficulty but the reason why it happens so may be demonstrated by an evident example. Suppose then a glass, or any other kind of Vessel filled with Water as high as A. B. if the sides of it be wet, the surface of the water will appear somwhat higher in the margine than in the middle. Put afterward in the Water a Nut-



ſhell or a little hollow glaſs Boul, or any thing elſe which is lighter than the water, we ſhall preſently obſerve it haſten to the ſide, and get to the height, and that ſo much the more ſwiftly as it is put in nearer the margin.

Pour in gently afterward more water fill and the glaſs, ſo that the water ſwell and riſe higher than the brim, A.O., as in this other figure, and forthwith we ſhall ſee the little bodies leave the ſide, riſe toward the middle, and reſt in I. or E.



But if you put in other little bodies that will ſwim, and are heavier than the Water to wit the duſt of Iron, Braſs, or any other Metal, the contrary will be ſeen, for they will fall down to the lower brim A. O. And when theſe ſwimming bodies that we have ſpoken of are ſucceſſively moved; that is when the heavier bodies

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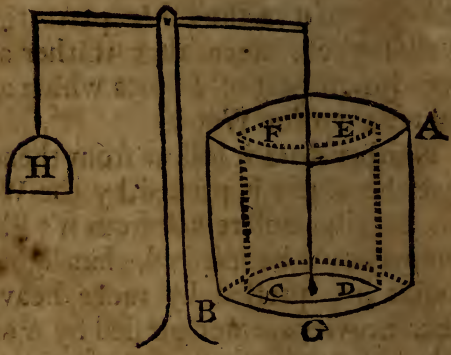
go to the ſide, then will the higher advance towards the middle, and contrarywiſe when the lighter bodies fall to the ſide, then will the heavier take their courſe toward the middle.

Hence appears that there is a greater preſſure of the waters at A. and O. than in the other parts that ſwell higher, ſince that thither are forced moſt part of Bodies which are lighter than the Water.

Neither does it follow from thence that the Water is preſſed by the Water, for like ſuffers not from it's like. But may only be inferred, that lighter bodies are preſſed by more heavy, when heavier are not preſſed by more light. For how much you force any body that is heavier than water under the ſurface of the Water, ſo much will it ſuffer, that is to ſay it will ſuffer nothing at all. But bodies that are lighter than Water by how much they are ſunk deeper, by ſo much more they feel weight and ſwiftly aſcend. Nor does Water preſs Water, but on-

ly ſuch things as are lighter than itſelf, and ſo indeed by how much greater the weight of the Water is, by ſo much will the preſſure be. You may eaſily make the experiment of it in this manner. Let there be a



Veſſel A. B, in the bottom of which put a wooden board D. C. it is manifeſt that if you pour in Water, the board becauſe it is lighter than the Water will riſe to the top. But let the bottom be opened, and a hole G. be be made, then will it not aſcend but will

will be preſſed by the *Cylinder* of water C. D. E. F. which by how much the greater it is, ſo much the more force will be required to pull out the board C. D. now if you apply a Ballance you will find that to raiſe the Board C.D. the weight H. ought to exceed the weight of the cylinder of water C. D. E. F.

Nor ſhould it be objected that preſſure ought to be in a perpendicular line, but not in ſuch points as decline from perpendicular. For although in theforegoing figure the Body of Water preſſes the air that is under it in a reight line, yet it is otherwiſe in Waters that are incloſed & find no paſſage out. For ſeeing that is the nature of all heavy bodies, that they tend to the Center of the Earth not only in a ſtreight and perpendicular line, but likewiſe (if they cannot otherwiſe) in an oblique and inclined, the reaſon is clear wherefore Water, contained in a veſſel when it finds no paſſage downwards, ſwells up and endeavours to get out into the Air, and preſſes

the bodies that are under to the side, and if they be lighter than the Water drives them upward to the top.

And this seems to me (if not the sole yet) the chief reason why Ships in the Torrid Zone are hurried with a swift course towards the Equator. Which though it may be perceived at greater distance, yet it is most observable at the latitude of two or three degrees; for by how much they aproach nearer the line, by so much more swiftly are they carried towards this middle Circle of the World. Neither is it so, only in that Sea which lies betwixt *Affrica* and *America*, but likewise in all the *Pacifick* Ocean; for there also Sailers carefully avoid the middle tract of the Torrid Zone. But if the same difficulty of passing of the line happen not in that Sea which lyes betwixt the East side of *Affrica* and the *Indian* Islands, the reason may easily be gathered from what we mentioned before.

Neither is to be thought strange, that the Sun declining from the Equinoctial,

noctial, and being in the Tropicks produceth not the same effect which happens under the line; nor how it can be that the Current whereby the Seas decline to the South and North, carries not with it, or at least inclines not that way the swelling which we have described. For the reason of that is clear enough, since the very nature of equipoise and ballance requires that waters should flow thither where the motion is swiftest, that is say is to say, to that Circle which of all others is the greatest. If in a vessel we turn water round, we presently see that the water it self and all bodies that swim thereon leave the Center and hasten to the greatest and highest Circle (that is) to the brim of the Vessel.

From hence also the reason may be easily given, why Galleys and any other kinds of Ships when the tide makes lanch out from the Shore to the middle of the Sea, which is commonly called high Sea, when nevertheless the Sea is higher at the Shore than

than in the middle when the Tide maketh. The same is to be said of the Gulphs which are commonly called whirlepooles. For there it is thought that the Seas are lower and that they fall into deep Caverns or Pits of the earth, when notwithstanding wheresoever there are Gulphs, shelves or such places in the Sea which are called by the Dutch *Mael storromen*, even there also to the very eye the waters are elevated. And the bottom of the Sea in such places is not deeper or full of holes and pits, but higher, and for the most part there are Rocks underneath which occasion the swelling of the Water. For wheresoever the bottom of the Sea riseth, there likewise it's surface swells: And so because that Ships naturally incline to the higher level, therefore such places are (if not in time forseen) fatal to Sea Men. Wherefore they who being in such danger, throw their goods over board, do no more but by hastening to lighten their Ship accelerate their own shipwrack.

CHAP.

CHAP. XI.

That the body of the Water is by Heat dilated and contracted by Cold.

ALthough daily instances and experiments do prove that heat does rarify and dilate Waters, and cold contract and condense them, it is nevertheless by some denied, and that for two reasons chiefly. For first they urge that if the bulk of water could be lessned and contracted, it would follow that in two Cylinders of equal capacity, but unequal in depth, there must be more water contained in the higher, than in the lower, because that the inferior waters are less pressed in this, than in the other longer Cylinder. But this is an erroneous argument, seeing no fluid and Homogeneal body presses it self. For Water in Water, and Air in Air hath no weight or pressure.

The other argument is fetcht from this,

this, that if the Seas and Ocean were rarified and did swell by heat, it would come to pass that when the tide maketh, Ships should draw more water then at low water. But neither does this argument prove any thing. For the Seas in their highest tides do not by the six thousand part rise higher, as we shall shew more clearly hereafter. Therefore although Ships do then draw a little more water yet the difference is altogether insensible.

That which they urge likewise is false, to wit that water cannot by any force be compressed into a lesser bulk. There is force required even to the compressing of Air. But water being almost a thousand times thicker than Air, there is almost a thousand times more force required to the compressing of the one than the other. Nor does this hold only in fluid bodies, but also in solid. For by how much any body is more heavy and compact, so much the greater

ought

ought to be the force which may ſtreighten this more compact body into a narrower compaſs. If therefore we ſuppoſe gold to be twenty thouſand times more compact than air, there is alſo need of twenty thouſand times more force to compreſs gold than air. And the ſame is the rule of the diſſolving and melting of bodies by fire. For by how much a body is more compact or of cloſer texture of parts, ſo much more intenſe ought the heat or fire be to diſſolve or rarifie it.

It will moreover eaſily appear that water may be by moderate heat or cold rarified and condenſed, if we take a glaſs bottle of a big belly but narrow neck and mouth, and being full of cold, put it into hot or lukewarm water: At firſt the warme water does contract it ſelf, though but for a minute of time, and makes the cold water upon the ſudden touch ſink a little, but immediately after the cold water aſcends and that in a manner proportionable to the warm water that

ſur-

ſurrounds it without. But if you warm the water contained in the bottle and ſet it in cold water, the the contrary is to be ſeen. For at firſt the hot water riſeth a little by reaſon of the ſudden touch of the cold, which endeavouring to force the heat out of the mouth of the bottle, forceth likewiſe the water upward. But this mementany motion being over the bulk of the water is by piece and peice contracted until by degrees it ſink to the lower parts of the Orifice.

CHAP.

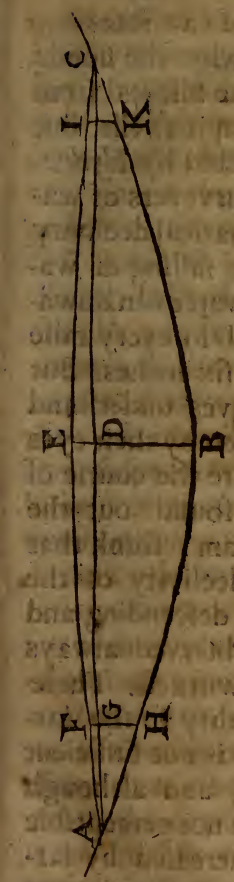
CHAP. XII.

The measure and place of the greatest swelling of Seas.

SEing then that water, as well as other bodies may according to the greatness of heat and cold, or with proportion to any other compressing body, be dilated and contracted, it remains in order that we should declare the measure of the greatest swelling of Seas. Now although that in some places, as in the *Bay* of *Bristol*, at St. *Michael's* hill and elsewhere the Tides some time rise above seventy feet, yet we can take no argument from thence, because that in the *Bays* and *Creeks* of our Seas that motion proceeds from another cause, as we shall presently show; but that we may know aright the primary and cheif motion of tides, we must enquire how much the Seas which lye betwixt the Tropicks do swell, and that not upon the Shores but

but in the middle Current where they are deepeſt. And there by the univerſal obſervation of all men, it is certain that the Seas ſwell not above two or three feet, yea that hardly can there be remarked betwixt their greateſt decreaſe and increaſe the difference of two ſpans not only at *Hiſpaniola*, *Cuba*, *Jamaica* & the *Charibe's*, but alſo on the moſt part of the Iſlands of the middle Ocean, whether thoſe that lye in the *Pacifick*, or *Indian*, or likewiſe the *Atlantick* Ocean, though even there alſo the Tide riſeth ſomewhat higher, than out in open Sea, where there are no Iſlands. If therefore we take our meaſures aright, we ſhall find that betwixt the higheſt and loweſt ſwelling of the Sea there is hardly the difference of one foot to be obſerved.

Now if the Sea where it is deepeſt do ſwell but ſo little, the riſing alſo upon the Shores is altogether imperceptible, where notwithſtanding the greateſt Tides are to be ſeen. Let the bottom or Channel of the Sea in this



this figure be A. B. C., and the ſurface thereof A. D. C.

Let the greateſt ſwelling D. E. be one foot high. And the greateſt depth of the Sea D. B. be ſuppoſed two miles, or 12000 feet. Now if the whole Sea in the deepeſt place thereof, do not ſwell above one foot, it is manifeſt that near the Shore, to wit at F. H. or I. K. the riſeing of the Tide can hardly be obvious to ſenſe. For if D. B. that is 12000 feet give D. E., that is one foot; and G. H. be ſuppoſed one hundred foot deep, then will not the ſwelling in G. F. exceed the hundred

and twentieth part of a foot.

Hence then is clear why the floods ſet always towards the Shores from the middle Ocean when it ſwells. But nevertheleſs it is objected by *Hydragogers* and practical Surveyers of waters, that this Mathematical declivity is not ſufficient for the falling of water, but that to make water run downward there is required in every mile at leaſt a deſcent of ſix inches. But theſe Artiſts themſelves underſtand not what they ſay, when by their eyes and ſenſes they meaſure the courſe of waters, and having found out the ſwiftneſs of the Stream, think that they fully know the declivity of the Channel, as if water deſcending and falling downwards obſerved always the ſame time in its ſwiftneſs. There is not the leaſt inequality in the ſurface of waters, which is not ſufficient to produce a motion, and although in the beginning it be not perceptible to ſenſe, yet being encreaſed by farther progreſs it becomes conſpicuous enough; eſpecially if the waters run

upon

upon an even and ſmooth and no rough or craggy declivity. But although this rule of Artiſts may ſometime take place in Rivers, ditches and other waters limited by a ſhort Channel, yet it ſignifies nothing to our preſent purpoſe, ſeeing the nature of the Ocean is far different. For although that it chiefly ſwell in the middle, yet becauſe the Sun is not always in the ſame point over head, but moves always ſucceſſively towards the weſt, therefore not only in the ſeveral ſpaces whereon he ſhines, but likewiſe in the ſeveral points, the ſame ſwelling every where, and the ſame declivity follows and remains: the firſt ſwelling notwithſtanding by reaſon of the ſuccedaneous waters (whereof we have ſpoken) which come flowing from each ſide, ſtill continuing; yet ſo that by how much the Sun declines from the middle, and by how much the depth o the Sea does decreaſe, by ſo much alſo the ſubſequent ſurface of the Sea does leſs ſwell, if we conſider at leaſt the

floods on the Shores; but if we consider the waters that by a progressive motion flow from the middle of the Sea, it riseth even higher and flows more swiftly, than the middle Ocean.

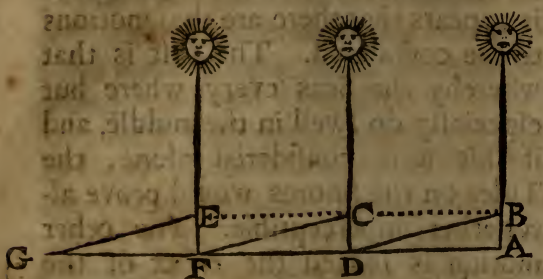
CHAP. XIII.

Wherefore it is that the Tides are greater on the shores than in the middle of the Sea.

BUT let us see if we can give a reason a little more clear, why that the Tides do rise so high on the Shores, when the swelling of the middle Ocean is so small. It will without doubt appear (strange and contrary to *statick* principles, that when the point from which Seas do flow does rise but only one foot higher than the rest of the surface, yet on the Shores where the floods beat, they swell sometimes above eighty feet, seeing the reason of ballance does

does not seem to allow, that they should rise so much as one foot. But from what we have said a little before it appears that there are two motions to be considered. The first is that whereby the Seas every where but especially do swell in the middle, and if this were considered alone, the Tides on the Shores would prove altogether imperceptible. The other motion is indeed the effect of the former, yet much more sensible and rapid, and so much still by how much it is more remote from its original. For when the Seas by the approach of the Sun begin to swell, they forthwith move towards the West to wit to a lower level. But because the Sun stands not still, but continually advanceth, and successively warmes the subsequent parts of the Ocean, that Sun following Current is necessarily also accelerated. When in every point to which this luminary is vertical the declivity and descent is renewed and restored, it cannot otherways be but that the course of the

waters ſhould be encreaſed. Suppoſe (as in this figure) the ſurface of the



Sea A. G. which ſwelling by the approach of the Sun is raiſed as high as B. it is manifeſt that the waters by the declivity B. D. will fall downward. But whilſt the waves ſo fall, the ſeveral points alſo of this declivity do by the Suns approach ſwell. The Sun therefore being right over the point D then alſo ſwells that portion of the Sea, and is raiſed as high as C. ſo that the level inclined downward in B. D. mounts up in B. C., and becomes paralel to the ſurface A. D. the Sun afterward enlightening the declivity C. F., this likewiſe ſwells until that the declivity C.F. be elevated

ted in C. E., and become parallel to the ſurface D. F. and the ſame is to be ſaid of the declivitie E. G. for it likewiſe ſwells in the ſame manner and ſo forward.

It is evident then that the Tide of the Sea like *Archimedes*'s pully by deſcending always riſes. Now then ſeeing all heavy bodies by deſcending accelerate their motion, it alſo appears why on the Shores the Tides are more conſpicuous and high than in the middle Ocean from whence they fall.

Nevertheleſs we muſt not think that this motion of the Ocean is in the ſame manner always accelerated, as bodies which roul downward upon a ſlopeing level. For there are vaſt Continents, Iſlands and the unevenes of the bottom which hinder the whirling motion, and ſometime the want of ſucceeding waters which either ſtop or delay this falling Current, do likewiſe withſtand. But yet if there were no impediment of Continents and Iſlands, and that the Ocean did

cover the whole globe, and flow in a plain and mathematical surface, the swiftness of the Current would always encrease; but the degrees of encreasing would never become so great, that the Ocean should move as fast as the Sun, to wit fifteen degrees an hour.

CHAP. XIV.

Wherefore it is that the Tides are greater in Temperate Zones than in the Torrid.

WE need not many arguments to prove that greater Tides are raised in the Temperate than Torrid Zone, since this is confessed by most men who have any experience of things. Let us take for an instance the seas which are not far distant from our own; for at St. *Michael*'s Hill by *Bristol*, and other places of the French and British coasts, the Tides sometime rise to seventy foot, and some-

sometimes higher. The same is to be observed in the Temperate Zone of the Southern Hemisphere. In the River called *Galegos*, at the *Streights* of *Magellan*, and the neighbouring Shores of the land of *Fuego*, the Seas swell above sixty feet: though the Tides in the Torrid Zone when they are at the highest, do not by far, rise to this measure. But that these things may be a little more accurately understood, we must altogether distinguish the Tides which happen on the Islands that lye in the middle of the Ocean, from those which are found on plain Shores, and in Bay's and far distant inlets of the Sea.

Wherefore the Islands that lye in the middle Ocean of the Torrid Zone, such as St. *Helena*, and others before mentioned, when the Seas swell to the highest, receive no Tide above a foot and an half or at most two foot high. And if it happen (as sometimes it doth) that the Floods mount higher, it is to be imputed to sudden gusts or other Winds which are but very

rare

rare in these Seas that are far remote from the Continent. But in the Islands far distant from the middle Zone, such as *Hetland*, and these twelve called *Fero* or *Faro*, with many others situated in the middle of the Temperate Zone, or at least who are far distant from the continent and greater Islands, the greatest Tides rise about four foot high.

Upon the Shores that crook not into *Bay*'s but with an even and streight front receive the Ocean of the Torrid Zone, as well in *Brasil* as in many other places, the Tides are seldom found to exceed seven or eight feet height. But on our Shores and on the coast of *France* and *Portugal* they swell as high again.

Although there be a great many long *Bay*'s in the Torrid Zone, which receiving the Ocean with a large mouth, are afterward contracted into a very narrow space, and thereby occasion high Tides, yet there are but two which are chiefly taken notice

tice of, the one at *Cambaja*, and the other the *Bay* which reacheth from *Martaban* to the City of *Pegu*.

When the Ocean flowes in these *Bay*'s the Tide riseth fourty two feet high. But on the Coast of *Normandie*, at St. *Michael*'s Hill and the Town of *Orange*. The Flood riseth fourscore feet and sometimes higher. And that is almost the same measure of the Tides at *Bristol*.

Now although it may be clearly enough understood from what we have said in the preceeding Chapter, why the Tides are greater in the Temperate Zone than in the Torrid, and that the farther they are distant from their original the more they swell, there is nevertheless another consectaneous reason which may evidently prove that the same thing must of necessity be so. For there are two motions to be considered in the Torrid Zone, to wit a swelling, and a progressive motion. Now though the former produce the latter, yet if

we

we would ſpeak properly, it is not the ſwelling, but the progreſſive motion which is the cauſe of the Tides upon the Shores. But this progreſſive motion is weaker and ſlower in the Torrid Zone, than in ours; not only becauſe it is nearer it's original, but alſo becauſe the Current thereof ends not there, but either declines to one ſide, or having performed a ſhort circulation, is again ſwallowed up by the Cavity which it left behind. Let us take for example the Coaſts of *Braſil*; where although the Ocean ſeems to ſet towards the Land, yet it beats not violently the Shore, but either ſlides aſide as we ſaid before, or having finiſhed it's Circle does with other lateral floods flow back to fill up the vacuity left behind. The Tides thereof which happen there and elſwhere in the Torrid Zone, have not a reciprocal flux and reflux as here with us, but are compenſed by the affluence of the lateral waters, and are there far leſs violent. But theſe waters which do not reflow but proceed

ceed farther, and follow the course that we have described. although haveing accomplished spatious circulations they return again to their Original, yet because they make greater Circles, whose parts severally considered come near a direct and rectilineal motion; therefore also is their course far more rapid than that of the former; and indeed so much the swifter by how much they are more streight and approach nearer the place whether they tend. Nevertheless we must observe that if they decline too far from their original toward the South or North they grow weaker and flag by degrees, experience telling us, that the Tides in the remotest Northern places are less than those that happen with us. Yet that the Seas do also set thitherward is manifrom this, that they who in the Spring and Summer go the whale fishing, do often in a fourtnights time or sooner, from *Holland* reach *Spitsberg*, when for the most part in their return they spend double the time.

But

But it may be perhaps asked, that seeing the motion of the Sea is so much more rapid in the Temperate and cold Zone than in the Torrid; whence comes it to pass that where the Current is swifter, there also navigation is not spedier? But the reason of this is clear enough. For in the middle Zone the Waters set constantly Westward, and never flow back again in the middle Ocean, therefore for the most part the course is equal. But in the other Zones when the Seas flow backward the same way as they did forward, it cannot otherwayes be but that by the contrary Current, though it be but small, Ships should be retarded.

CHAP.

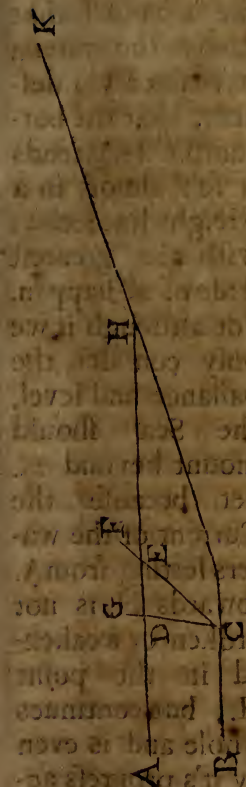
CHAP. XV.

The reason why on some Shores there are none or very small Tides, and on others great and almost incredible Floods.

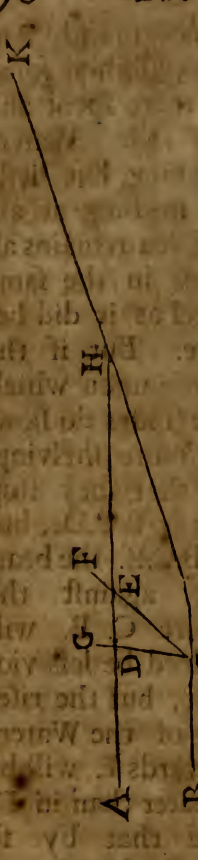
WE have spoken of the difference of Tides that happen in the Temperate and Torrid Zones, it now remains that we explain the general cause why all the world over in neighbouring countreys and upon neighbouriug Shores in some places the ebbings and flowings of the Ocean are great, and in others almost insensible. Many men have observed that the greatest Tides happen in those *Bay's* which receiving the Seas in a large and wide mouth do afterward contract themselves into a narrow Channel. Although this reason be true, yet it is not sufficient alone, since by experience it is known that there are many *Bay's* in several places to be found, that from most large mouths

mouths draw into a moſt narrow breadth, where notwithſtanding the Tides are very ſmall. That we may therefore have the intire cauſe of this matter, we muſt take notice that the Flood of the Ocean is indeed encreaſed or diminiſhed, by reaſon of the ſituation of the lands wherewith it is on each ſide encompaſed; but far more from the quality and ſituation of it's ground and bottom. For whereſoever the ground of Shores is deep, and riſeth not gently, but with a ſteep and abrupt bank, there are always the ſmalleſt Tides. But where the Shores which are beaten by the Sea riſe with a gentle and eaſy aſcent, there are the Seas elevated higheſt, and ſo much indeed the higher, by how much leſs that plain bends. Suppoſe then the Sea A.B.C.D. ſetting in a full body and at a Spring Tide from A. B. towards C. D. now if it meet with a ſteep Shore C. D. the Waters will very little or not at all riſe in the point D. for becauſe the Waters beat ſtrongly againſt that point, as hitting

almoſt



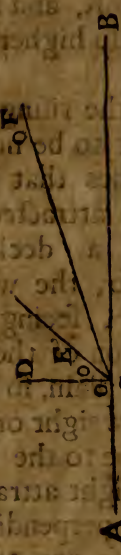
almoſt in right Angles, all their force is there ſpent and ſo the Waters ſwelling but little or nothing at all, the Sea remains almoſt in the ſame level as it did before. But if the Shore upon which the Tides do flow, be more ſhelving, ſo that they ſtop not at B.C.D., but at B.C.E. the beating againſt the Shore C. E. will indeed be leſs violent, but the riſeing of the Waters towards F. will be greater than in D. and that by ſo much the greater by how much the Angle BCF. is bigger than the Angle B.C.G. But if



the Channel that carries the waters, have so easy a descent, that the bottom B.C.H. extends it self almost in a streight line; then will the greatest Tide of all happen. For although if we only consider the ballance and level, the Sea should mount beyond H. yet because the Current of the waters setting from A. towards H. is not broken or weakened in the point H., but continues whole and is even by it's progress accelerated, seeing that into the narrower space that waters are confined, the swifter they move, therefore with full

full force it advances to K, and swells not only longer, but also higher than either at D. or at E.

But this reason of the rising and falling of Tides is not to be measured by the rule of bodies that by a determinate weight are attracted, or forced forward upon a declining plain, for if it were so, the waters would rise much higher, seeing that such as is the proportion of the perpendicular, to shelving plain, so must likewise the attracting weight or protrusive force always be to the body forced forward, or weight attracted, so that one pound in a perpendicular may be sufficient to raise any weight to any height on a plain that gently shelves; but this mounting of Tides that we have discoursed of, is to be examined by the rule of bodies projected which ascend but a little on a shelving level. Suppose then for demonstration, the horizontal level A. B. and the perpendicular falling right on it C. D. it is manifest that if you throw any Ball or Spherical body



from A. towards C. it will not ascend to D, but return in the same streight line that it went in, towards A. but if the same ball, by a like impulse be trinled from A. to the shelving level C. E. though indeed it strike against C. yet it will rise a little higher, to wit to E. Now if the ball thrown with the same force mount the plain C. F. it will not only go farther but likewise rise higher, to wit to F. and if any one intend to try or examine these things more accurately, he will find always that according to the measure of the Angle against which the ball or any projected body does hit, so likewise the motion of projected bodies does encrease or diminish.

But

But that we may return to our purpose, this reason is so vniversally true, that let a man travel all the World over, he shall hardly find one place, where that according to the proportion (which we have shown) of Shores, the ballance of the Floods and Tides is not adjusted. Wheresoever the Shores are deep and fortified with high and steep Rocks as the the Shores of *Norway* and many others; there the highest Tides scarcely rise above six or seven feet; but if the same be shallow, the Tides are immediately greater. Nor is this only observable on Shores, but every where also on Shelves and Banks, for the more easily the bottom of the Seas do swell, the higher the surface of the Waters rises.

Hence the reason is evident why at *Bristol*, at St. *Machlow's* Church, but especially at the Town of *Orange*, and St. *Michael's* Hill in *Normandy* there happen such strange Tides. For there the Shores rise with an easy ascent and are smooth like a looking

glaſs. And when the Tide goes out are often left bare for the ſpace of ſeven or eight miles, ſo that the Ocean retires out of ſight not only to thoſe that inhabit the Shore, but to thoſe alſo that live on St. *Michael's* Hill, who otherwayes living on the continent when the Tide makes, become almoſt Iſlanders.

Neither is there any other reaſon to be given of theſe wonderful Tides (whereof we ſpake before) which happen at *Cambaja* & the City *Martaban*; they deſerve both to be mentioned, eſpecially ſeeing in explaining the reaſon of them, many men have to no purpoſe wearied their brains. The *Bay* therfore of *Cambaja* opening in a large mouth to wit from the Caſtle of the *Portugueſe* which gives the name to the Iſland *Diu*, to the oppoſit Iſland, which hath it's name from *Cowes*, ſtreatcheth in breadth at leaſt five and twenty German Leagues. By degrees afterward it contracts it's ſides, which on each hand in a long tract runs North and North-Eaſt, until at *Cambaja* and the entry of the River

River *Carcario*, which by a miſtake is confounded with the mouth of *Judus*, it draws together into a narrow corner. The length of the *Bay* from the mouth to it's innermoſt creeke reacheth thirty German Leagues. The inner part of this *Bay* at low Water is altogether dry, (except that in the Channels of the Rivers here and there a little Water is to be ſeen) and a vaſt plain reaching ſome Leagues appears on all hands. But when the Moon draws near it's quarter, then in a full body the Ocean comes ruſhing in, of the force of whoſe approach, watchmen who from high watch-Towers ſee it a far off do by ſound of Trumpet give warning. For theſe high Mountains of Waters flow inward with ſo much rapidity, that the ſwifteſt Horſe at full ſpeed is not able to outrun their Current.

But more wonderful yet is that other Tide which we mentioned, and which is to be ſeen in the *Bay* that lyes betwixt the City of *Martaban* and *Pegu*, wherein it is falſly thought

that the River *Ganges* disburdens it's moſt Eaſtern Streams, ſeeing the River that runs by *Pegu*, hath no communication with *Ganges*, as we have ſaid elſewhere. This *Bay* is longer then that of *Cambaja*, reaching above fifty German Leagues, but in the ſame manner from South-weſt to North-Eaſt. The middle Channel thereof riſeth with ſo eaſy an aſcent that it approacheth next to an Horizontal plain. The ſides ſwell with Rocks and little Hills: When the Sea is out almoſt all that plain that lyes betwixt the mouth to the innermoſt creek thereof is naked. But when the Tide begins to make at quarter Moon, ſo great is the noiſe of the Flood-water, that all the Country about ſhakes; the firſt Flood is moſt violent, the middle is alſo ſo rapid as to break in pieces any Ship, but not ſo ſtrong as the former. The Waters that flow laſt, (the *Bay* and wider Channel being now full,) abate much of their force, until after ſix houres ſpace, the Seas become moſt

calm.

calm. When this laſt Flood makes (which the Dutch call *Achter vloet*) the *Bay* becomes navigable, and then the Ships that are bound from *Martaban* to the City of *Pegu* ſet forth. When theſe that ſail in the middle and lower level are in danger unavoidably to be caſt away, on the contrary, Sea-men find a ſecure road upon the Rocks and tops of the Hills. For before that the Tides ebb and ſettle to the tops of the Hills, they bear of, and having caſt Anchor the ridge of the Hill ſerves them for an Harbour. There they ſtick until the the next Tide make, which at firſt breaks in with fury, and is ſwift as an Arrow, but as by degrees it mounteth, it abateth of it's force, ſo that at ſix Fathom Water, the Ships being afloat, wye and with a favourable Tide get to another anchoring place, and ſo on, until after ſeven times coming to Anchor they at length arrive at the City of *Pegu*.

And theſe are the two Tides in the Torrid Zone which of all others are eſteemed

esteemed the most memorable, and yet if we consider the height of the flood, they match not those which are to be seen on the coasts of *Britan* and *Normandy*. But it is here chiefly to be observed, that although both these floods happen in the Torrid Zone, yet they are to be considered as if they were without it. For seeing that in the *Indian* Sea (as we have said) by reason of the situation of the lands the Sun-following Current of the Ocean inclines toward the South, it cannot otherwayes be but that the Current that sets contrary to the Sun should that way incline also, which in that Sea even when it reacheth shortest, extends it self as far as the *Equator*. So that from thence it appears that these Tides being occasioned by the Current that sets contrary to the Sun, are to be esteemed like those which happen in the Temperate Zones.

Moreover I make no question if there were any *Bay's* of that shape on our coasts, but that the Tides would

would rise much higher, than where now they rise to the greatest height. Or even in our Sea which ought rather to be called a Frith than open Ocean, if the Tides which beat the coast of *Holland* did flow upon a plain Surface, and were not broken by Banks and Sand Beds (as they call them); it is not to be doubted but that even a moderate North-West Wind blowing, they would surpass the Downes themselves. But if the Islands of *Britain* were placed in some other part of the World, and that the Ocean did not side wayes, but in a streight course set upon our coast as it does upon the other Shores of *Europe*, this our Country and a great part also of the *Netherlands* would become Sea or at least a great Inlet.

CHAP.

CHAP. XVI.

It is shown that many things are falsly ascribed to the Moon, and that she is not the cause why Oysters and other Shell-Fish do fill.

WE have attributed the cause of all the motions of the Ocean, whereof we have hitherto discoursed, to the Sun alone, as being such to which the Moon neither can, nor ought to pretend any title. Now let us consider if the Moon hath any power upon the Tides of the Sea, especially on the diurnal, and monthly as they call them. As to what then concerns the faculty and effects of the Moon, I wonder that so many having ascribed the principal cause of the Tides of the Sea to this luminary, have notwithstanding asserted it's beams to be cold, as if cold could produce a swelling, or that there were any light destitute of heat. Because forsooth the beams of the Moon

are

are weak, especially if they be compared with the Sun's, therefore they will have them to be cold, and not at all hot. But who sees not that this argument proves just so much, as if one should pretend that the Moon does not shine, because it's light is very small if it be compared with the Suns. As it happens in many things that our senses deceive us, so do they especially in this case: because our blood is hotter than Water, therefore though it be a little lukewarm, we think it cold, whereas even when it appeareth most cold, it is not altogether void of heat. They are wonderfull men, who seeing that some people walking abroad by Moon light have catch't cold and a cough, have concluded that the beams of this Planet must be cold. But if in the Winter time a man should in the day time walk abroad in the open Fields, and fall into the same distemper is it therefore to be inferred that the Sun in Winter is cold.

I think we need not stick upon that

then

then whether the beams of the Moon be cold or hot, seeing that there is no light which considered by it's self does not contain at least some heat. But the reason is manifest enough why we do not feel the heat thereof, for as by day the Moon shines not, because she is darkened by a greater light, so neither can the sense of heat which the lunar rayes spread in the night time, reach us; because that the Air in which we breath even after the Sun is gone, continues notwithstanding to be hotter, than all the heat that the Moon is able to transmit to us. Let us suppose the Moon to be equally illuminated and warm'd as the earth is by the Sun, (which nevertheless is not easily admitted by a great many;) yet the heat of it could not reach us although it were a hundred times nearer to us than it is, seeing things that are equal, affect not their equals. So that it is no wonder that even *Thermoscopes* though assisted by burning Glasses are not affected by the light of the Moon.

As

As it is absurd then to ascribe cold to the beams of the Moon, so neither ought any sensible heat to be attributed thereto, but especially such an heat that being in other things insensible, yet in moving and exciting of Tides is of greater force than the Sun himself. Let those that think so, clear themselves as they can, how it comes to pass that in the Currents and Tides spoken of before, when the Moon has no share, yet in Spring Tides as they call them, without the help of the Sun, she alone performs all.

But there are others that think that the Moon may yet have other faculties whereby she may be able to move the Seas. For they say, the influences of the Moon are so conspicuous in raising and setling of Tides, in filling and emptying of Crabs, Oysters, Lobsters, Cockles and other Shell Fishes, and that according to the proportion of her waxing and waining, that no reason of man can be able to exclude the effects of this

Planet.

Planet. And truly this reaſon hath appeared ſo preſſing to the moſt part who have written of the ebbing and flowing of the Sea, that not being able to find any ſubterfuge, they have been likewiſe forced againſt their will to acknowledg and allow to the Moon the Empire of the Ocean. Wherefore I hope my labour will not be loſt, if I evidently prove that they who think ſo are much miſtaken, and that all theſe effects would in like manner happen if there were no Moon to ſhine in the Heavens.

Now as concerning Oyſters and other Shell Fiſhes, which are believed to encreaſe and decreaſe with the Moon, my opinion is: That it is not the Moon or any influence thereof, which makes theſe Creatures ſwell and grow fat, but the Tide it ſelf of the Sea. In many places of *India* as at *Cambaja*, *Bengal*, the Iſle of *Iava* and elſewhere, at the new and full Moon Shell Fiſh are for the moſt part empty (as I have had it from eye witneſſes) and the ſame at quarter

Moon

Moon are full. For on these Coasts there is no Tide to be perceived, when the Moon is either new or full, but four five or days later, according as the Ocean later or sooner approacheth to these places. Wherefore in the *Bay* of *Cambaja* and *Pegu*, when the Moon is in it's quarter, then do the Seas swell highest, but when in the new and full they fall again. Hence it appears that it is not the Aspects of the Moon but the coming of the Tides which crams the Oysters. Nor are they indifferent as to what drink they bib; for they cast out their draughts of dead old musty water, and upon the approach of the Spring Tide and fresh waters from the middle of the Ocean, they open wide their Shells, until with natural and wholsom food they be fully refreshed. And even hence also you may know the truth of this, that if you give new Salt Water to Crabs and Oysters whom you keep prisoners, you may prolong their lives for many days. But if out of any standing pool of Salt water which hath al-

ready contracted ſome ill quality you pour in dead Water (as they call it) upon them, they loath, caſt it out like ſpitle and in a ſhort time pine away.

CHAP. XVII.

What is the reaſon that there happen two Tides every four and twenty houres.

WE have, (unleſs I be miſtaken,) ſufficientiy proved that at the approach of the Sun and eſpecially when he is overhead, the Seas do ſwell. Now let us ſhow the reaſon why every day and night they flow twice and ebb as often. Whether the Moon contribute thereto any thing or not, we ſhall hereafter conſider; but now let us demonſtrate what in this caſe would happen, if there were no Moon at all. Therefore I aſſert that if it were ſo, yet the Seas every twenty four houres would flow

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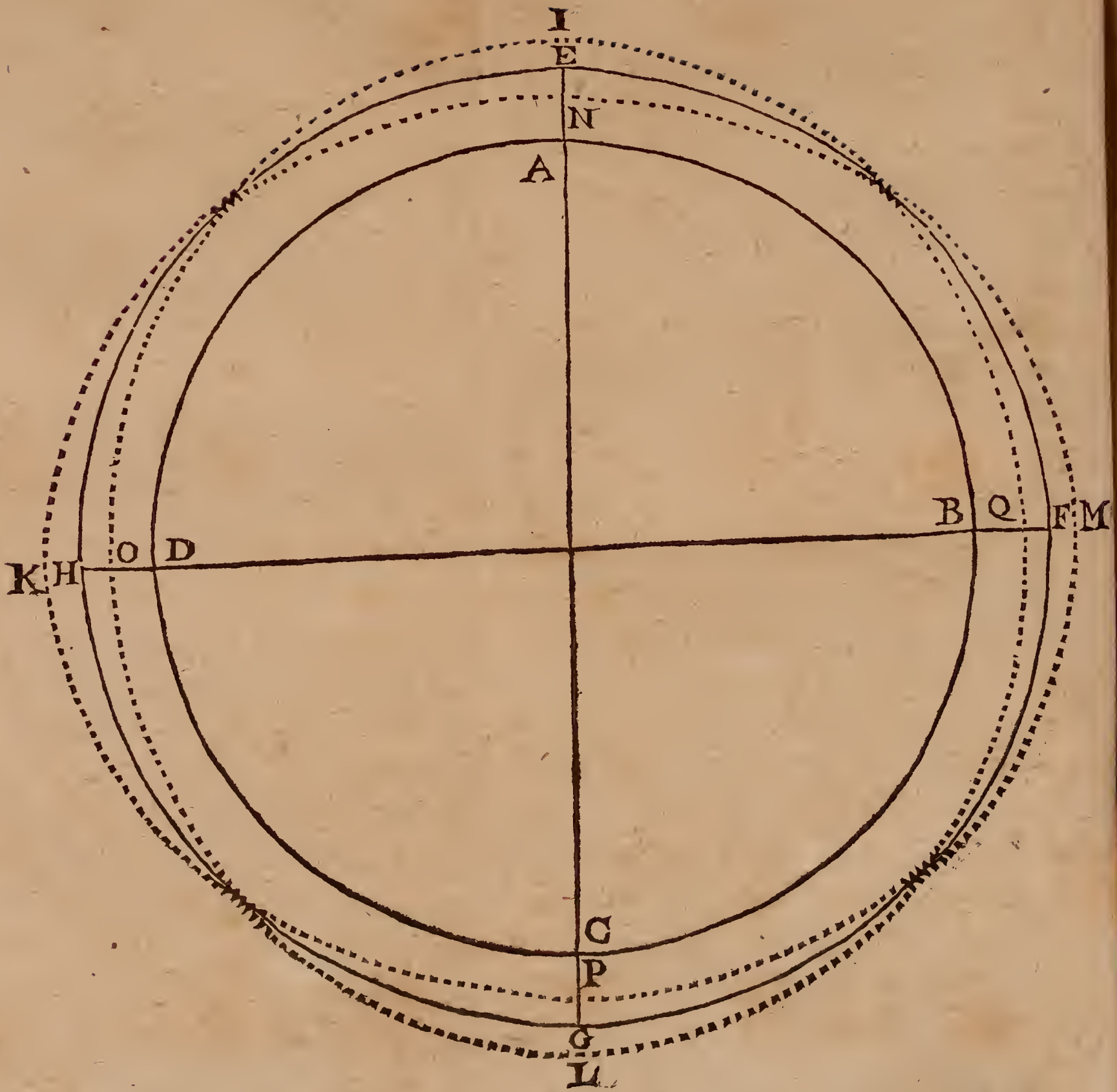
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twice and ebb as often. Suppose then the earth to be A. B. C. D. and the Sea that environs it E. F. G. H. let the Sun be vertical to the part A. E. and according to what we have said the Ocean will swell and rise as far as I. Six houres after the Sun will be overhead to the points D. H. and then the Sea will rise as high as K. in the mean time the swelling in I. will fall, not only as far as E, but also a little lower to wit to N. but when the Sun becomes perpendicular to the points C. G. and that the Sea is elevated to L. the Ocean a quadrant or six houres distant will in the mean time settle to O. but because all motion must have it's restitution, it will happen in the mean time that the Sea which is distant the whole Hemisphere will again rise and swell to I. or somewhat lower, because the restitution of Motion according to the laws of nature ought to be less than the primary motion. Let the Sun afterward be vertical to the points B. F. and the Sea swell as high as M, then will the

ſwelling in L. abate, and the Sea ſettle as low as P. and the Surface in O. will be again advanced to K. or thereabouts, and the riſing in I. will fall again to N. or ſomewhat leſs. For that decreaſe ought to be a little leſs than the former, becauſe the encreaſe thereof was alſo ſomewhat leſs by reaſon of the diſtance of the Sun. But when that the Sun comes again to be right overhead to the point I., then the ſwelling returns, and will riſe as high as I, if not higher, unleſs the contrary motion, whereof we ſhall diſcourſe hereafter, hinder.

If we conſider the Period of the ebbing and flowing of Tides, I think no more proper cauſe can be aſſigned for it, than what we offer, for thereby we ſhall have no need to betake our ſelves to any oppoſit Moon, nor to juſtle the earth out of it's courſe. Seeing even the neceſſity of motion requires this rule; for all motion that retains liberty of Action, does neceſſarily expect it's reſtitution. Therefore whether we ſuppoſe the earth in

all

all parts equally encompaſſed with the Ocean, or that we let it alone as now it is; it is abſolutely neceſſary that whereſoever, or howſoever, whether up, or down, or every way the Seas do ſwell or are moved forward, the ſame motions ſhould ſometime return, and ſometimes mutually change. And unleſs this motion were daily renewed by the Sun, it would at laſt after ſome turns back and fore either altogether ceaſe, or at leaſt become inſenſible.

Nor ought we more to be ſtartled at this, why in the oppoſit part of the *Meridian*, and in the point moſt remote from the Sun, the Sea ſhould ſwell, than why in the points of Eaſt and Weſt where the Sun at noon beats moſt obliquely there ſhould be the greateſt abatement of it's tumor. Since where the Suns action ceaſeth, there the reſtitution and ſupply of the former level ought to begin, and becauſe the ſame ballance and level returns not by the firſt reflux, but ought ſucceſſively and by degrees to be reſtored, it is evident why in that

point which is fartheſt diſtant from the Sun there ought to be the greateſt Current, & higheſt ſwelling of the waters, but ſo ſtill, as not to be altogether ſo great, as that which twelve houres before hapned in the ſame place.

Now from what we have ſaid before it may eaſily be gathered, how this motion is reſtored in the Torrid and how in the Temperate and Frigid Zones. For in the Torrid Zone the Seas in many places have no reflux, but are obliquely and ſidewayes again ſupplied. But in the Temperate and Frigid Zones where the Seas ſwell only by a progreſſive motion, there, for moſt part they return the ſame way that they came.

But ſo far we have digreſſed, now let us return to our buſineſs that we may conclude that the Flood or Tide which in all places of the world comes in the night time to that part of the *Meridian* which is oppoſit to the Sun, is nothing elſe but the reſtitution of of that Tide, which happened twelve houres before in the ſame place, and that it would be ſo though no Moon were exſtant.

CHAP.

CHAP. XVIII.

What is the reaſon that every day the Tides of the Sea happen fourty eight minutes later.

NOW let us come to that motion which is only common to the Ocean with the Moon, and let us explain the cauſe that makes the Tides of the Sea fall every day (as the Moon doth) ſo many minutes later, that is 48 13 16 minutes or almoſt four fift parts of one hour. And that I ſhall in a few words diſpatch. The Seas flow ſix houres, and ebb likewiſe ſix. But becauſe after this motion is over, the Sea continues to move, and that the ſame motion muſt of neceſſity be reſtored, it again flowes ſix hours and ebbs as many. So that in twenty four hours the ſeas go twice back and fore, if we reckon only the times of their flux and reflux, and by this means the courſe of the Seas is equal to the motion of the

Sun, or (to say more truly) of the earth. But seeing that the Sun or Earth advance always in a continued and uninterrupted motion, but that the Seas having finished their course whereby they tend to the Shores or end of their motion, do not instantly flow back, but do for some time remain without any sensible motion, in suspense, as it happens in all reciprocal motion, which such a motion necessarily requires: It is clear that to the times and spaces of the several flowings and ebbings of the Sea there ought to be added also the time of delay or of the slower motion, which passes betwixt the several fluxes and refluxes. Now although that this interval may even by the eyes be clearly enough perceived, yet because the sight of the eyes is often deceitfull, and the Tides are often kept back or hastned by the Winds, it will be the surest way to compute the measure thereof by the daily retardation. Seeing then that the Tides are retarded every twenty four houres

and

and come later by 48 minutes, it is manifeſt that to the time of every flood there ſhould be added twelve minutes, and as much to every ebb; ſo that it follows clearly that the retardation of the Tides depends not on the courſe of the Moon, but that it ought neceſſarily to be ſo, by reaſon of the motion which they have from the Sun. But how it ſhould come to paſs that by the ſame proportion and meaſure of time, the motion of the Moon ſhould alſo be retarded, I think will ſeem ſtrange to no body who knows that the Sphere, which the Moon by her courſe deſcribes is elliptick, and that it muſt therefore neceſſarily happen, that that planet ſhould appear to move ſomtime faſter, and ſome times ſlower; ſlower when ſhe is fartheſt diſtant, and ſwifter when ſhe moves nearer to us. But if any body ſhould further ask for what end needed ſuch a motion and ſuch a retardation to be. let him go and learn from Sea-men whether it affords them little advantage and comfort

comfort that they have in the Heavens a luminary, which with it's various countenance and motion does every where so constantly and faithfully represent to them the so various changes and vicissitudes of Tides. The Moon therefore moves not the Seas, but only markes the spaces and times of their motion, and is not the efficient cause, but as the Index and rule of the Tides which in many places happen in the Sea. Nor is this the only advantage (though great) which that variety of Lunar motions performs to this our earth; there are a great many others that spring from thence for the use of Mankind, which any man who is desirous, may fully and clearly learn from the books of Astronomers, whom (if he pleases) he may consult. The Moon was made by the great Creatour not that it should rule and govern the Seas or earth, but only serve and wait upon them, not that it should be the cause, but only the signe and measure of time and of the seasons

of

of the year, as the holy Scripture affirmeth.

CHAP. XIX.

What is the reaſon of the encreaſe and decreaſe of Tides.

IT is fit we ſhould now give the reaſon of that Tide which is commonly called the monthly or Spring Tide, when it ſhould rather be named the fourtnight or half monthly Tide. For it does not abſolve it's period as the Moon doth in a month, but every fifteen daystime. One week the Seas ſwell, and one alſo they fall, after the end of which time, they again recover their former level. They then who ſay that the Tides of the Sea increaſe and decreaſe with the Moon, are miſtaken, ſeeing that it is only ſo, one half of the month; for the other half when the Moon waneth the Tides increaſe. But that it may more clearly appear that it is not the

the Moon which causeth so different motions in the Sea, we shall explain the true cause of this rising and falling of the Waters. And this is it.

The earth in the space of twenty four houres is wholly enlightned by the Sun; but the Seas absolve not their two fold ebbing and flowing till fourty eight minutes later. The Sun then is sooner vertical to the same point again, than the Seas by their reflux can again fill it up. Wherefore the motion of the Ocean is for sometime contrary to this new motion of the Sun, and is thereby a little retarded. For the seventh part almost of it's swiftness abates. But twenty four houres being again exspired, and the Sun perpendicular to the same point; the last reflux of the Sea will be for the space of an hour and thirty seven minutes contrary to the Sun, so that now the course of the Seas will be more interrupted. For the fourth part and more of it's motion or celerity is abated. The third day the Sea

loseth

loseth the half of its swiftness. And after the first day is over the third part of it's celerity only remains, and so forwards; so that by how much the reflux of the Sea falls later, by so much it grows weaker and that even to the eighth day, when the Current and reflux fist, because the times of them become even, and the motion of the Sea alike with that Current which the Sun does daily renew. For seeing upon that day the Sun is vertical to the same point, and the course of the Sea retarded whole six houres, that is a whole ebb; therefore two Currents meeting with equal force, the contrary gorging with it's contrary produce a tranquillity and calm. But that day being over, the Seas again begin to flow and ebb, and because the Sun-following Current of the Ocean is by no contrary Tide or reflux interrupted, therefore the Tides daily augment, until that upon the fifteenth day they rise to their highest pitch. And then again after the manner that we have said the Seas begin to decrease. And

And this is indeed the true reason of the encreasing and decreasing of Tides which are observed all the world over. From whence it is evident that we need not forge any new motion of the earth, or recur to occult qualities, seeing even the nature and necessity of motion hath established this course. And truly if there were only one Sun-following Current which moved the Seas, Tides must needs swell to a vast height. Therefore nature hath wisely provided against this, by making one contrary motion bridle and repress another, by the help whereof there is an equality setled, and the over-swelling Seas again made level. For if such a motion were continued but a few days, there would be no land which would not be totally overflown. And it may be easily collected that the very tops of the Hills would be covered, if we do but calculate the measures of the Seas encreasing. Wherefore it is to me a wonder that amongst all those who have written

of

of mechanical force and power, there is not one (that I know of) to be found, who hath made any mention of the force of Reciprocation, when not withstanding by the help thereof vast weights might be removed out of their place, and that in shorter time than by any other force whatsoever almost. Let us take for an example of this the greatest bells, or even laden Vessels which Boys with hands and feet alone do easily and swiftly move. And I my self have tryed by experience that taking hold of the branch or rather of a rope tied to a Tree, great and old Trees may be pluck't up by the Roots, and that in a very short time, provided that the Jirks of reciprocation be exactly observed.

Furthermore if any be so curious as to desire to see illustrated or somewhat more clearly demonstrated by similitude or example, this compound motion that is now accelerated and by and by again retarded, I think they may be easily satisfied. Let them sup-

ſuppoſe then as in this figure a circle erected I. O. V. which in four and twenty houres whirleth round, let this have a certain point O., which by it's approach alone without any contrart, may move the pendiculum A. K. which we ſuppoſe to be ſo long that in the ſpace of ſix houres it may overrun the quadrant of the circle. But becauſe the motion of the pendulum is not uniform, but the aſcent in the end and the deſcent in the beginning is ſlower than it's middle courſe; let us add to every vibration that is to every ſix houres, twelve minutes according to what we have ſaid. It will therefore come to paſs that whilſt the pendulum accompliſhes four vibrations or two reciprocations, the circle will not only fulfill it's compaſs, but will likewiſe anticipate the motion of the pendulum 48 minutes. Therefore the moving point at O. the ſecond day will meet the pendulum at B. which having now loſt ſome part of it's motion, will but ſwing to (b), and having finiſhed other

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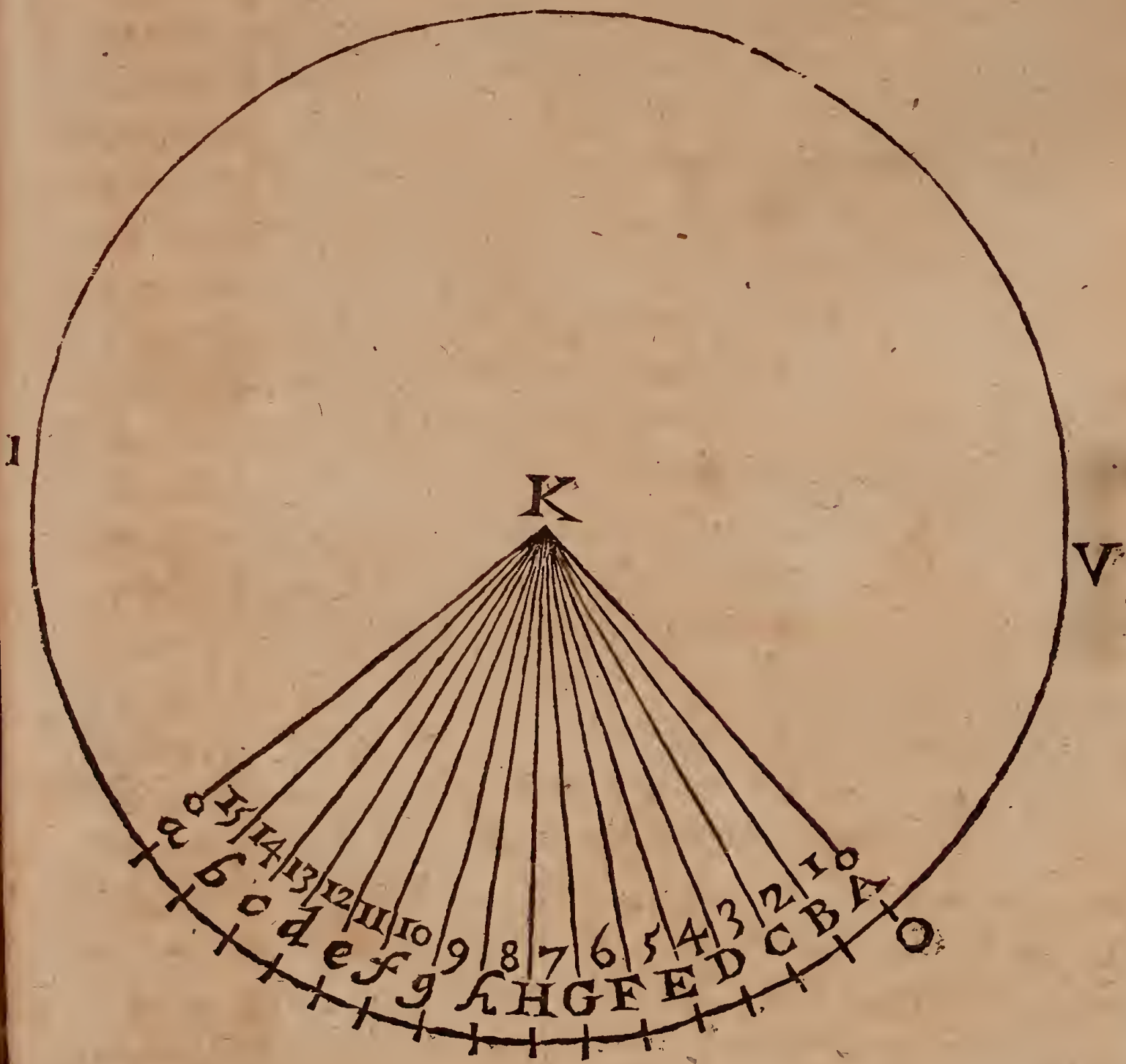
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four vibrations it will meet the moving point in C., from which it will fall off as far as (c) the day following the moving point will come to D., and then the pendulum will be moved from D. to (d), next day from E. to (e), and afterward from F. to (f), the seventh day that point which moves being advanced to G., then will the excursion of the pendulum be limited by G. (g), four motions of the pendulum being again past, that is, on the eight day the moving point will be in H. ; and then because the force of the moving point and the pendulum is equalled, either the motion will be very small to wit from H. to (h.) or none at all, the pendulum resting in the middle, that is, in a perpendicular. And hitherto the motion of the pendulum loses some part by the occourse of the moving point. But now the order is contrary : For as in the former swingings the motion of the pendulum was day by day more retarded because of the occourse of the meeting point, so in these that

follow, which begin after the eighth day, the farther that the moving point falls off from a perpendicular, the vibrations of the pendulum are quicker and longer. For the contrary motion being taken away, the point does not follow any more, but goes before the motion of the pendulum. And what spaces it had formerly cut off from the several vibrations, does now add and restore as many. And the rest, or that least motion which the perpendicular cuts, being over, and the moving point advancing to (g); thither also the pendulum is forced, which in it's second turn not clashing with, but equally for some space proceeding with this point, is not (as before) cut short of fourty eight minutes, but daily by so many advanced. So that the moving point being in (f) the pendulum reacheth as far as (g.) And by a like proportion advances to (f.) (e.) (d.) (c.) and (b.) to these several spaces diverting it's course. Then upon the fifteenth day when the pendulum is raised and advanced

ced to (a.) at last it makes it's longest reach and compleats it's period; and then again the course and recourse of the pendulum according to what we have said is lessened by degrees.

But although for clearer examples sake we have here described a pendulum that moves through a whole quadrant of a circle, I would have on body therefore think, that such a space is necessarily required to make this period just and uniform. For let the measure of the pendulum be what it will, and the Seas that are moved of what extent soever, provided they do move; the same order and measure of reciprocation will always continue.

Furthermore I would have no man imagine that this compound motion sutes more to pendulum's, than to fluid and continuous bodies. For let a man fill an oblong vessel with water, and at first let him make a uniform reciprocation, and afterward introduce another motion, which in due time

and place may either follow or proceed the former, he ſhall find the ſame viciſſitude of acceleration and retardation, which will appear from the ſides and the mutant bodies ſo much more conſpicuous, as the veſſel is longer. And indeed ſuch a motion of water will ſomewhat more exactly repreſent the Tides of the Sea, becauſe that there is no need that the moving cauſe ſhould change places. For ſeeing that the body of water fills the whole Veſſel or Channel, that double motion whereby the whole body of it is affected may be made in any any point thereof, provided that at any one and the ſame time we ſtir not the Water. But ſince the Pendulum fills not all the ſpace wherein it moves, but poſſeſſes only one point thereof, it is neceſſary that the moving cauſe likewiſe move, unleſs we would ſuppoſe ſuch a Pendulum, that in performing it's reciprocations, together with it's orb turns round.

Let us then conclude that ſo diffe-

rent

rent viciſſitudes as are theſe which are to be found in the Tides of the Seas, can neither be underſtood nor demonſtrated but by ſome compound motion, which by reaſon of that that it is mix't and compounded, does neceſſarily require that it ſhould ſometime be accelerated and ſometime retarded. So different an effect cannot cannot be produc'd by a ſimple cauſe. That I may therefore in a few words make an end, I affirm that the Tide whereby the Seas encreaſe to the 8*th* day, and fall again to the next eighth, comes from no other cauſe but the different occourſe of the Sun and Ocean, And that the Tides are increſed and accelerated if the Current formerly made by the Sun agree with the freſh ſupervening Floods, and that they are again retarded if the poſteriour motions claſh with ths former.

CHAP. XX.

By what means and with what intervals, are the motions and Tides of Seas advanced.

WE have already explained the principal and (in some sort) universal motions of the Ocean, and derived the cause of all from the Sun alone, and that the Seas which reach far South and North would be dead and without motion, if they were not affected by the same Current. But yet we must not think that Water how fluid soever it may be, is so swift that it can from the middle Zone in so short a space and so few houres come posting hither to us, but that the Ocean being continuous, and the Seas mutually touching one another, it is only the motion that continued. That vertue is on all hands communicated by contract. So that the Shores most remote, provided that they receive without impediment or obstacle the

access

acceſs of any great Ocean, have at the ſame time their Tides. That this may be the more eaſily underſtood, we ſhall meaſure the Tides according to the courſe of the Moon; not that thisPlanet by it's influence moves the Seas as we have already ſaid; but for cuſtoms ſake, and becauſe the Ocean as to it's daily retardation, in it's motions anſwers to the motions of the Moon.

When therefore the Moon about three houres after ſhe hath paſſed the *Meridian*, is South-Weſt, it is Tide on the Shores of *France*, *Portugal* and on all that coaſt of *Affrica* which reacheth from the Streights of *Gibralter* to the *Cape of good hope*. But that in ſome places, as at *Cape Blanco*, *Sierraliona*, and on ſome of the Shores of *Guynnee* and *Congo*, the Tides happen later, the reaſon is not obſcure, for there as in many other places, banks and beds of Sand retard the approach of the Ocean.

But that on the other hand upon the Shores of *Spain* which reach from

the Streights of *Cadiz* as far as *Algarbia*, the Tides make somewhat sooner. (For immediately after the Moon has been in the *Meridian* in the parts nearer to the Streights the Sea is full;) there seems no other reason to be given, but that the Floods (whereof we have discoursed) coming out of the *Mediterranean* Sea setting constantly towards the coast of *Spain*, and which are conspicuous to all Navigators, meeting with the Ocean raise it's surface, and accelerate it's motion. Therefore in the mouth of *Ava* the Tide makes an hour sooner, but in the Streights themselves above two. For an hour after the Moon hath been in the *Meridian* and even a little sooner, the Sea there is full.

But the reason is far otherways in other Friths, Bay's and mouths of Rivers by reason of the frequent impediments of land which retard the course of the Ocean. At the outmost and most Western Promontories of *France* it is highest Tide about three houres after South Moon. Then the

farther

farther the Ocean runs in into the Channel that lyes betwixt *Britain* and *France*, the later are the Tides. So that in the *Streights* betwixt *Dover* and *Calais*, high Tide is twelve houres later: upon the Shores of *Flanders*, *Zealand* and particularly in the mouth of the *Maese*, it is again retarded, so that at *Roterdam* it is full Tide three houres after South Moon to wit twelve houres later. And before that the same Tide reach *Amsterdam* twelve houres more are expired, so that the people of *Amsterdam* have one and the same Tide thirty six houres later then they who live on the Shores of *England* and *France* that lye open to the Ocean.

There is a greater retardation yet in Rivers. At the mouth of the *Garon* the Tide is three houres after the Moon hath past the *Meridian*. And the same Tide comes twelve houres later to *Bourdeaux*. But at the Town of St. *Macar* the Tide makes not till eighteen houres after, so that for every German league, the Tide is almost retarded an hour. And

And these are indeed the Tides on the coasts of *Europe* and *Affrica* which are all occasioned by that Current of the Ocean which is contrary to the Sun, or at least obliquely thwarts it according as the lands and Shores do lye. Now seeing the Western coast of *America* does lye in the same manner, as the above named Shores of *Europe* and *Affrica*; the same is likewise the manner of their Tides. The Moon being therefore South-West, it is full Sea upon the Shores of *Chile* and *Peru*. But on the opposit Shores, as the Tides, so are the times far different; for on the coast of *China*, *Tunchin*, at the Isle *Formosa* and elsewhere in that Sea, it is full Tide when the Moon is South-East and North-West.

Upon the Shores of *Florida*, *Virginia*, and new *Holland*, it is likewise highest Water when the Moon is between South and East. For the same proportion that the Western coast of *America* bears to the aforesaid Shores of *China* and *Tunchin*, the same also does

does those of *Europe* to the opposit lands of *America*.

Now that we may attain to a more distinct knowledg of these motions, first we observe, that we must not reckon the begining of the Tides which every where happen, from the new or full Moon, but from the quarters. For seeing that all motion begins from rest, and that the least, or no motion at all is perceived when the Moon is in the quarter; it is manifest that the period of Tides is comprehended within that space that reacheth from one quarter to another. But because that between the quarters and the new or full Moon there passeth an interval of seven days and a half, and the Tide in the mean time is retarded six houres, we must substract that space, that we may have the begining of the motions of the Ocean.

Therefore upon the coasts of *Europe* and *Affrica*, where the greatest Tide at new and full Moon happens at three of the Clock after noon, it is clear

clear that the first motions did begin at nine of the Clock before noon, that is above three houres before the Sun reached the *Meridian*. Now if we pursue the same Tide, which with the Sun-following Current sets Westward, we shall find by experience, that about an hour and a half later it comes to that promontory of *Brasil* which juts farthest out to the East. And as the Current of the Ocean advanceth farther Westward and arrives at the River of *Amazons*, and at *Guyana*, the Tide will likewise follow. For when there at full Moon it is high Water at six of the Clock, at the quarter it must needs happen six houres sooner; to wit at twelve. More-the Current of the Ocean setting Northwards to the *Bahamean* Streights, *Florida*, *Virginia*, and new *Holland*, the Tide likewise accompanies it; and because at new and full Moon as the Shores are nearer or more distant, the Tide happens at eight or nine of the clock, it is manifest that at quarter Moon it happens

at

at two wo or three, and in ſome places alſo later.

From hence may be drawn a ſolid argument, that between the Tides that waſh the *European* Shores, and thoſe that happen on the oppoſit coaſts of *America*, there is the difference of almoſt ſix houres, and that therefore when in theſe Shors there is the greateſt Flood, in thoſe others there is loweſt ebb, and contrarywiſe.

And the ſame is courſe of the *Pacifick* Sea, for ſeeing that at three of the clock in the afternoon at the new and full Moon the Sea ſwells higheſt upon the Shores of *Chile* and *Peru* and that at nine of the night, the greateſt Tides are found to be upen the oppoſit coaſt of *China* and *Tunchin*; it is clear that at the quarter, the Tide will happen on the coaſt of *Chile* and *Peru* at nine of the clock in the morning, but in the oppoſit Shores at three afternoon.

CHAP.

CHAP. XXI.

That there is a true motion of the Air, and that the Air observes the same rules in it's motion as the Water doth.

IT is vulgarly believed that there is nothing more unconstant or unsetled than the Wind. And the (truth is) if we ran over these things which an infinite number of Authors have wrote of the nature and quality of Winds, we can hardly be of any other opinion. For what we read every where upon that subject, is so empty and frivolous, that if any person greedy of knowledg should addres himself to the books of Philosophers, he would leave them a great deal more ignorant than before. Who can hear them affirm without laughter, that Easterly Winds are dry, but Westerly, moist: and again that the North Wind is high, but the South wind low? Is not this without any

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acquaintance with nature blindly to play the Philosophers in a study? But waving what other men have said, let us see if we can propose any thing more certain our selves.

Seeing then that the Air is the subject of Wind we will begin with it. We justly reject the fable of the four elements as many others done, and believe that the Air is Water or a dilated humor every way extending itself according to the rule of equipoise or ballance. Which although it may be produced from Lakes, Rivers, Snow and elsewhere, yet the principal sourse of Air, are the Seas, and that so much the more, by how they lye more under the Sun. Therefore in Countreys that are either too dry, as the middle of *Libia*, or too remote from the Sun, as under both the poles, there is either rarely, or no air at all; except what comes from other places. It is likewise clear that the Sun by rarifiing and dilating of moisture raises divers motions. And if these motions be easy and gentle,

they

they are called Gales, if more vehement Winds, and if very rapid and boisterous, Storms or Whirle-Winds, and this also (if I be not mistaken) is by most men acknowledged.

Now seeing every motion of the Air produceth Wind, we should but loose time to explain the manner how Air can be moved Though any one may reckon up a thousand ways of raising Wind, yet for all that he shall not be able to know from whence they come, whether go, and by what rule blow; these general Winds which at set times and places move the Seas, refresh the land, and convey to us our natural breath, without which we could not subsist. Wherefore they who explain the rise of Winds by the motion of a Fan, show nothing else but this, that the motion of the Air causes Wind. They who endeavour to give the reason of Winds from brasen *Æolus*'s (as *Vitruvius* calls them) or Wind Balls, only prove that humour dilated, and flowing out of a larger space through a narrow hole

moves

moves moſt ſwiftly. They ſay ſomewhat more that think they can declare the original of Winds by this experiment, that if in a cloſe Chamber you kindle a Fire, the incloſed Air will rarify, and open the place, into which the Air without will with a whiſtling noiſe enter by the chinks and ſeams of the Door and Windows. Altho the ſimilitude be fit to prove that the Sun does with his heat and rayes rarify the Air, and cauſe other Air from all hands ſucceed into the place of that which was rarified, which by it's motion raiſes Wind; yet this reaſon is more proper to illuſtrate the manner how Whirl-Winds and certain ſudden Guſts happen on Shores, and ſometimes in the middle of the Ocean, than to demonſtrate that univerſal courſe of the Winds which accompany the Current of the Water, and does ſurround almoſt the whole World. We muſt altogether take the ſame courſe to find out the cauſe of this, which we did in explaining the Currents and Tides

of the Seas. For as in searching out the beginning of Tides, we told you that these places are not to be consider'd where the Seas do most swell; but those where first they are perceived to move, since all motion begins from rest, and cannot of a sudden attain it's greatest swiftness; my opinion is, that the same is to be done in inquiring into the original of the universal Wind; nor should we take notice where it is that the course of the Winds is most violent; but consider the original where they began to blow. Since then we have sufficiently made appear, that the Seas and circumbient Air in the Torrid Zone do by a like progress always tend Westward, and have moreover declared the manner, from whence it may be manifestly learned why the Seas move so; I think it not to be doubted, but that the same reason should in like manner take place in the course of the Air, and that so much the rather, that the Air being lighter than water, is more ready for motion. For the Sun

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dilates the body of the Air, and raiſes it's ſurface higher. Now ſeeing that motion proceeeds from higher to lower, and that the ſurface to which the Sun is, or lately before was vertical, is higher, the courſe and fall of it muſt be neceſſarily Weſtward, which though in the begining it be ſmall, yet it increaſes more and more by progreſs, as we have before illuſtrated.

Having now ſet down that primary motion whereby the Air that is under the Sun is affected, let us now race it's progreſs : And therefore what we have ſaid to happen in the Ocean of the Torrid-Zone, happens alſo in the Air. In the ſame manner and almoſt in an equal courſe, both haſten to the Weſt. Nor need we inquire whether the Current of the Waters hurry with it the Air that is over it, or that the motion of the Air move the Seas ; ſince that the rayes of the luminary being propagated in an inſtant, at the ſame time, though not in the ſame meaſure both Elements (as they call

them)receive the impreſſion. As long as they are both in the ſame caſe, ſo long with equal pace almoſt they haſten to their mark, and mutually incite one another. It is true indeed, the motion of the Air is ſwifter in the begining; but we muſt conſider that heavy bodies do by progreſs acquire greater encreaſes of motion, ſo that ſometimes it falls out that the Current of the Waters is ſwifter than the Air, although that the ſame thing may alſo proceed from another cauſe. Yet for the moſt part the motion of the Winds is more rapid than the Current of the Seas, and indeed though there were no other reaſon why it ſhould be ſo, this alone were ſufficient, that the bottom of the Seas on which they move being very unequal, retard their courſe; when on the contrary, the Winds ſlide upon the ſmooth face of the Waters.

But when the flux of the Ocean is ſtayed by the Sun-following motion, as at *Braſil*, or upon the Eaſtern coaſt of *Affrica*, or other Shores of the Torrid

Torrid Zone, which receive from the East the Floods of great Seas, the case of the motions become different. For where the Sea beats with a full body, it declines (as we have said before) to the South or North. But seeing the Air that is over it and advancing therewith, strikes not against any impediment objected; for the most part it continues it's motion, and for some space advanceth right forwards, blowing upon the opposit Lands. And from hence spring these comfortable gales which in the day time refresh *Brasil*, *Madagascar*, and the Eastern parts of *Affrica*, and with a breese of Sea-Air qualify the (other ways) excessive heat. For commonly three houres after Sun rising, that is about nine of the clock, a constant East Wind begins to breath, which lasts till three or four in the afternoon. But after Sun setting the Air returns to the Sea, and makes place for the land Winds, as shall be hereafter explained. But the Wind or course of the Air that deviates from

the ſtreight courſe, to wit, which in ſome part thereof is by the motion of the Ocean carried of ſome part of the one or other Shore, it follows the ſame motions of the Ocean ſo long as the form of the Shores is the ſame. But if it happen that they are crooked, and do ſideways receive the Current of the Waters, then it may again happen that ſome part of the Air take another courſe, and advance ſtreight forward, and this will be ſo if the Shores be plain, and that no riſing of Hills reſtrain the progreſs of the Air. For we muſt know that as the Currents of the Seas are bounded by Shores; ſo the courſe of the Air is terminated by Mountains; nor (as I conceive) is there any thing that happens to the one which agrees not with the other. If a man, that is an aireal creature, could ſubſiſt alive above the Air, and that the motion of the Air were as diſcernable as the Current of Waters, he would ſee the ſame viciſſitude of Aireal Tides upon the ſides and tops

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of Hills and the ſtreights of Mountains, as now are perceived in the Sea. The high and continued ridges of Hills would appear like Shores, but lone and ſeparated Mountains, as reſembling divided Iſlands.

CHAP. XXII.

A motion of the Air contrary to the Sun explained.

WE have before explained the Current of the Seas that is contrary to the Sun, which on each ſide hems in the middle Current of the Ocean. And we took notice alſo, that not only the Water but likewiſe the Air is affected with this motion, ſo that in the temperate Zones, this alſo in a conſtant courſe ſets continually from Weſt to Eaſt. Now as this motion of the Seas is reſtorative of the former, when having abſolved it's circuit, it doth perpetually refound new, or rather the ſame waters; ſo likewiſe does the air always ſucceed to its ſelf, and from

each side breathing in again, makes up the vacuity or lower level. The nature of both does so fully resemble each other, that I know not so much as one thing wherein they differ; especially in the middle Ocean, where the Current of the Seas and Winds is always the same. If the Waters flow softly, the trade Wind is likewise soft, and almost insensible. If by a Storm, Whirlewind or Flurrie, the Seas are enraged, or whirled about in a round, the same motion also is perceived in the Air, and although in *Streights* and upon Shores because of the apparent inconstancy of the land Winds this similitude does not always agree; nevertheless in these Friths. and on these Shores, where the motion of the Seas and Winds is contrary to the Sun; there happens no remarkable difference, and that but very seldom, and of short duration. Therefore on all the Coast of the Northern *America*, that is opposit to the *European* Shores, Easterly Winds are almost unknown. There, for the most part in Summer

blow

blow only South-West Winds, and in the Winter North or North-West. For as the Seas so in like manner the Air and Winds do not beat against, but fly from the Shores of *Florida*, *Virginia*, *New-Holland* &c. But the contrary happens on the coasts of *Europe*, whither almost perpetually that Sun-contrary Current of the Seas and Wind setteth. And therefore it is no wonder that on the coasts of *France*, *Britan*, *Holland*, and *Spain*, which lye open to the Ocean, for the most part of the year Westerly Winds blow. The same happens in the Sea which washeth the Northern parts of *China*, where there are never, or but very seldom, any Sea Winds, which blow almost perpetually in the opposit Shore, to wit, on the coast of North-*America*.

CHAP.

CHAP. XXIII.

The Annual motion of Winds.

BEſides theſe two motions, whereof the middle follows the Sun, and the other is contrary, we have ſhown likewiſe another, which is the cauſe that the two fore-named motions do ſometime decline to the South, and ſometime to the North. Neither in this does the condition of the Winds differ from the Seas. For as theſe for the ſpace of ſix months incline Southward, and the other ſix months Northward, ſo likewiſe are the Winds carried, whereof the ſame viciſſitude and change happens almoſt all the Ocean over. Nor is this to be obſerved in the Sea alone, but alſo (though not ſo conſtantly) in many parts of the land. Some days after the Summer ſolſtice the Winds begin to blow from North and North-Weſt. But after the Winter, the South and South-Eaſt come, though ſomewhat

what later. The Trade Winds which happen in the *Mediterranean* Sea, such as the Levants and North's, do sufficiently prove this. Nor is it otherwise in *Persia*, *India*, *Mexico*, and other Countreys of *Asia* and *America*. And even in the middle of *Affrica*, if there be any Winds stirring, when the Sun is in the Northern signes, they blow from South or South-East; and when he is again in his Southern progress, the North and North-West wind take place. To be short, what ever part of the World we go to, whether in the Northern or Southern Hemisphere, we shall find that not only great Seas, but also the middle tracts of great Continents, if there be no mountains to hinder, do for the most part one half of the year receive Winds that blow from the South, and the other half from North.

CHAP.

CHAP. XXIV.

Concerning land Winds, their cauſe and Original.

SEeing that there is no Country in the World which the Ocean waſheth, from whence Winds do not ſometimes breath, and that in many and almoſt all the coaſts that lye near the Sun, after Sun-ſetting the Land-Winds do conſtantly and perpetually begin to blow; a great many have believed, that all Winds whatſoever ſpring from the earth, and are land exhalations. And although they had before their eyes vaſt Oceans from ſuch effects might have been eaſily deduced, yet they rather choſe to fly to (I know not what) holes, Hills of Snow, little land Brooks, and Subterranean Caverns; as if the dry Earth and Rivers that often fail, could ſupply greater matter for theſe Aireal Floods, than the inexhauſtible Fountain of the Ocean. They thought that their opinion

nion was ſtrengthned by this argument, that upon Shores and places near land, the Winds are obſerved more violent than in the middle of the Ocean.

But I am ſo far from believing that moſt Winds are the off-ſpring of the earth, that I think theſe very Winds which are called Land Winds, take not their original from thence. We have explained the manner how that the Air or dilated humour breaking in upon the earth, does produce the Sea Wind. If this be admitted, which indeed neither can nor ought to be denied, it will neceſſarily follow, that the Sun being ſet, that is the cauſe which did dilate the body of the Air and Sea, ceaſing, both theſe humours muſt ſettle, and the Air return back to its own place, and ſo by its motion produce theſe Winds which are called Land Breeſes.

Now the reaſon ſhould not appear more obſcure, why that this motion of the Air or Wind is ſometimes more violent

violent in places near the *Shore* than in the middle of the *Sea*, than that the Tides are more impetuous upon the *Shores* than in the open Ocean. For what happens to the *Sea* when it beats against the *Shores*; the same likewise happens to the Wind, provided that the nature of the Lands which receive the course of the Winds, be the same with that of the *Shores* which are overflown by the Ocean. If therefore the *Shores* rise with high Hills, which the course of the *Sea*-Air cannot surpass, the Air is reverberated, and occasions great Winds, and even often *Storms* and whirle-Winds, especially about the time of the Equinoctial, when the force of the *Seas* and Winds is most impetuous.

And this is the true cause of these Winds which are called Land Winds, from whence is manifest that they are much mistaken who have judged that the Winds which about the evening blow back again from the land, do spring from thence, because that after Sun-setting there are more vapors rai-

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fed from the Land than out of the *Sea*, seeing (as they say) the Earth retains the heat wherewith it hath been affected longer than the *Sea*. But there is no body howmuch soever heated, that after the Fire or Heat which dilated the humour being removed, does not immediately cease to send out any vapour, and does not by degrees contract it self into a narrower space. Besides, it is not true that the Earth does longer retain the heat impressed by the *Sun*, than the *Seas*. For seeing that the heat pierces not above a foot deep or little more into the Earth, as it sooner receives, so likewise it sooner looses the heat than the *Seas*, which being many times of a vast depth, do not grow warm untill they be all alike heated. And though the bottom of the *Sea* is not altogether so warm as it's surface, yet it is known by other experiments as well as that of divers, that the tops of the Waters are never hot, but that the lower parts are likewise lukewarm. In

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a word, that all doubts may be removed, this one thing is sufficient, that when Winter seizes the land, and binds up every thing with frost, they who at that time are out at Sea, feel still Heat and Summer on the Ocean; so that Winter arrives at least two wonths later at Sea than at land. On the other hand when the cold departs, and heat again visits the land, the Seas still continue cold, so that they who in the months of *May* and *June* put out from land to Sea, think themselves often carried from the middle of Summer almost into the middle of Winter.

CHAP. XXV.

That in the Torrid Zone the Sea Winds are cold, but the land Winds excessively hot.

FRom what we have said in the former Chapter it may be clearly enough understood, whence it happens

pens that the Winds which in the Spring time blow from the Sea are colder than thoſe in Autumn, or even in the beginning of Winter come from thence. So that it is not much to be wondred at, that *Theophraſtus* and others believed the Seas to be hotter in Winter than in *Summer*, ſince it is known by experience that in the Torrid as well as other Zones there is often as much warmth to be found when the *Sun* is at greateſt diſtance as when he is neareſt. But ſeeing that there occur ſome difference betwixt theſe Contreys that lye in the Torrid Zone, and others ſituated in Temperate or cold climats, and that the variety is not ſmall that is occaſioned from the point from whence the Seas flow, it will be convenient to ſhow the manner whereby we may not only probably but even infallibly determine of the ſtate & temper of all Countreys almoſt, as to heat and cold. *Seeing* then that the condition of the Air does for the moſt part depend on the Winds, and that they follow the

Current and motion of the *Seas*, it is altogether consonant that this being known according to what we have discoursed of, the rule and manner of Winds which either infest or cherish the earth should likewise be understood.

Therefore whatsoever Countreys or greater Islands which in the Torrid Zone receive the Flood of the *Sea* from the East, when otherways they would prove inhabitable, are by the *Sea* Breeses so coolled, that they become not only habitable, but also most temperate. *Such* are particularly *Brasile* and *Madagascar*. There, the East Winds which allay the heat, blow continually from nine of the clock in the morning, until three or four of the Afternoon. But the reason from what hath been said before, is evident why the Eastern coast of *Affrica* which also lyes in the Torrid Zone, enjoyes not the same temper and seafon of Weather. For all that *Shore* receives the Current of the beating Ocean obliquely and not in

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a direct course. And although it were not so, yet there is another reason that hinders, to wit, that except that the kingdoms of *Quiloa*, *Mombasa* and *Melinda*; the other kind of Countreys of *Affrica* are a dry and altogether thirsty land watered by no Rivers. The same is the condition of the coast of *Arabia*, which though it be termed the [*Happy*] yet is so dry that it hardly affords Rivers enough for drink. We may then conclude that all these Countreys that lye betwixt the Tropicks, and that are refreshed by the Eastern Gales of the neighbouring Sea, if they be not destitute of Rivers, or that high Mountains intercept not the Sea-Wind, are justly to be reckoned most fertil and temperate.

But the condition of those Countreys in the Torrid-Zone which have the Sea to the West, is very far different. For seeing (as we have said) they receive no Wind from the West, but are wonderfully scorched by that perpetual East-Wind, which rains in

all the Torrid Zones, and is to them a Land-Wind, and therefore most dry; it must necessarily follow that these Countreys are miserably barren and almost inhabitable. For example let us take all the Western coast of *Affrica*, to wit, the kingdoms of *Gualata*, *Arguin*, *Hoden*, *Genehoa*, the Country of the *Jaloff's*, almost all *Guynnee*, *Benin*, and many other provinces which are parched with so great heat, that if you saw the inhabitants, you you would think they came out of a Chimney, and that you did not behold Men, but Sprights or Skeleton's. It is by most certain experience known, that in some places in these Countreys men suffer so much heat, that the very spirits by which they hear and see, are wholly consumed. This is particularly the case of the white *Moors*, who in the day time like Owl's are blind, but see in the night. And not only our Countrey Men but likewise the *Spaniards* have observed a kind of Men at *Papua* in the other *Guynnee*, which is beyond

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the Eaſt *Indies*, whom they call [*Albini*], whom they report not only to be purblind in the day time, but alſo for the moſt part deaf. *De Ruyter* who is certainly no lying witneſs, affirms that the ſame happen'd to him and his comrade in the Kingdom of *Gualata*, by the golden River as they call it, who were both almoſt bereft of both theſe ſenſes.

Neither let any man think that this general rule is falſe becauſe that the kingdoms of *Angola* and *Congo*, which are not unfruitfull, lye upon the ſame coaſt of *Affrica*, and that the ſame tracts of land which we have named are in many places very temperate and fit for cultivation, for that exception does it ſelf confirm what we ſay. Becauſe that when vaſt Mountains interpoſe which check that Eaſterly or land Wind, and ſtops it from blowing all over the Continent, it muſt follow that the cauſe being removed, the effect muſt likewiſe ceaſe. Now it is certain that in all the aforenamed coaſts, theſe places

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are only temperate and habitable, which by continued ridges of Hills that send out many Rivers, are hedged in on the East. Besides the above mentioned Kingdoms, such also are the tracts of land which lye by *Cape Verd*, *Theon Ochema* or *Sierra liona*, upon the *Bay* of St. *Ann*, and some others.

Let us now pass over into *America* that we may have a clearer example of this; we have told you, and it is known to all, that the coasts of *Brasil* by reason of the Sea-Winds do enjoy a temperate and healthful temper of Air, so that this Countrey is continually moistened by the dew of the Ocean. This is also known, that the farther these Sea-Winds are removed from the Sea and their original, they become so much dryer. Reason therefore requires and experience testifieth, that the midland parts of *Brasil* and the neighbouring Countreys, are exceeding dry, & that so much the more by how much they are remoter from the Ocean. This being so supposed,

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it must follow that the Countrey of *Peru* should be most dry and inhabitable, seeing that it receives no refreshing gales from the West, and ought especially by Eastern Winds to be dried. But it is not so, and I think there is no body that knows the name of *Peru*, who is ignorant of the happiness both of the soil and climat. So great a difference can proceed from no other cause, but from the vast and high Mountains which divide that Kingdom from the rest of the South-*America*. For these Hills stretching from North to South, reach from the Equinoctial even to the Streights of *Magellan*, and with a continued ridg extend themselves eight hundred German Leagues. They who get up to the tops of these Hills which admit of any ascent and passage, and allow a prospect toward the East, perceive all things there parcht and burnt up by the heat of the Sun and Easterly Winds. But if turning themselves they cast their eyes Westward, there they find and observe a wonderful

temperatneſs. Hurtfull blaſts are ſo excluded from all that valley, that in all the province of *Chile* and *Peru*, the names of Eaſt-Winds are equally unknown. There they have only South-Winds, which are occaſioned by that Tide, which as we have explained, make the Seas that are near the Shore ſet from South to North.

CHAP. XXVI.

That in the Temperate Zones the Sea Winds are hot, and the Land Winds cold.

AS the Current of the Seas and Winds in Temperate Zones, is contrary to that of the Torrid, ſo does it alſo produce contrary effects. For that Wind which there follows the Current and Tide of the Sea, and blows from Weſt to Eaſt, brings rather with it heat than cold.

In all the *European* coaſt which lyes

lyes open to the Sea, there is no Winter felt, as long as the Sea-Winds blow. It is true indeed that some Sea Winds are colder than others, and that South-West are warmer than North-West-Winds, yet whatsoever Winds do blow, provided they come from the Sea, they occasion no frost, nor any remarkable cold; but when the Land-Winds prevail, then happen great colds. And it is observed that when South-Winds blow, our Rivers of *Tener* freeze, then when we have a North Sea-Wind. And if any by a *Thermoscope* shall try whether in the Winter time the South-East, or North-West-Wind be coldest, he will certainly find the former to be colder. But what we say ought only to be understood of places near the Sea, for it falls out otherways in places far distant from it, where the Winds that reach thither losing the heat of the Sea, become cold Land-Winds. And hence it is that the most part of the Tracts of *Europe*, which lye in the same climate, are found so much colder

colder, by how much they are remote from the Ocean.

Moreover this is not only the condition of places that lye near the Sea, but much more of Islands, which enjoy even far more temperate weather, than the coasts of the Continent, seeing they receive no Land-Winds, but are on all hands cherished with the warm Breese of the Ocean. Therefore it is not to be wondered at, that the Winters are more mild and favorable in *England* and *Ireland*, than in *France*, and that the cold is not so sharp in *Scotland* as in *Holland* or *Germany*, and that the Winter weather is more temperate in Islands, than in *Lapland* or *Norway*.

But if any one should pass from *Europe* over to the oppsit coast of *America* that lyes in the temperate Zone, he would there find all things contrary. For seeing that the Tide of the Sea beats not directly but sideways against these Shores: it follows that the Winds which are occasioned by the motion of the Waters, blow

not

not full upon, but rather pass by or only gently touch all that side of *America*. Easterly or Sea-Winds, as we said before are not only rare, but almost unknown in all the *European* colonys there; to wit, in *Florida*, *Virginia*, *New-Holland* and *New-France*. There blow for the most part in these Countreys only Land-Winds, and they so cold in the Winter time, that it may seem strange how so great Winters can be, in so near a distance of the Sun. The Rivers in *New-Holland* in one night freeze so hard, that they may be safely past over a foot. And so great abundance of Snow falls, that scarcely in four or five months time after it is thawed and melted.

Now if another argument be still required for the confirmation of the same thing, waving the Countreys of the Southern Hemisphere, the Northern parts of the Kingdom of *China* will readily afford us an instance. We have said that no Easterly or Sea Wind, or but very rarely, do blow upon these coasts, and that the Land-Winds bear

the

the only rule there. Yet there happen so fierce colds in the province of *Pechil* or *Pechin*, which lyes notwithstanding more Southerly than *Spain*, the most Northern parts thereof scarcely reaching the two and fourtieth degree of Latitude, that for the space of four whole months, the most part of the Rivers are frozen so hard, that they bear not only Horses, but even the heaviest laden Carts and Waggons.

And hence appears that the same is the case of the coast of *China*, as of the aforementioned coast of *America*, which lyes opposit to the *European* Shores. But if we advance to the Western Shores of North *America*, we shall there find the same condition of the Air and Winds, with that which we have said is ordinary upon the *European* coasts.

Now if we pass to our *Antipodes*, and the Countreys of the Southern Hemisphere, we shall every where meet with the same observable rule; to wit, that the Lands and Shores

which

which receive the Current of the Sea from the West, are much more temperate, and less exposed to cold, than the opposit Shores which lye open to the rising-Sun. It is true that in smaller Islands this difference is not discernable; but the Continents or greater Islands proportionably to their greatness, do manifestly enough show a certain and determinate manner of the temper of weather; and that not only upon the Shores, but more in the Midland, which are so much the colder, by how much they are more distant from the Sea, and less moistened by the dew of the Ocean or of other Seas.

CHAP.

CHAP. XXVII.

How it happens that the Sea Winds are cold in the Torrid-Zone, and hot in the Temperate.

ALthough it may seem strange that the Seas between the *Tropicks* being not only warm, but almost boiling hot, should there produce cold, and the same being much colder in the temperate Zones, should notwithstanding breath heat; yet if any do but call to mind that which before we mentioned, when we treated of the original of Land-Winds, I think there will remain no reason, why it should pass for an absurdity. For seeing that the Land in the Torrid-Zone is hotter than the Sea, it is no wonder that this should cool and refresh that. But when the land which lyes at a great distance from the Torrid-Zone, is not much warmed by the Sun, nor can contract any heat by the contact of Lands

so

ſo diſtant; the Earth being a firm and ſolid Body, it is no way ſtrange that Countreys ſo remote from the middle region ſhould be very cold. Yet the Sea on the other hand being a fluid body, and continually moving in circuit, and the motion thereof extending every way, even to the extreameſt parts of the North, it muſt neceſſarily be, that even the moſt diſtant Seas ſhould be affected by the heat of the Ocean that is in the Torrid Zone. And ſo the reaſon is clear why the Sea-Winds within the *Tropicks* are colder than thoſe that blow from the Land though in cold Countreys they be warmer.

CHAP.

CHAP. XXVIII.

The reaſon why the greateſt motion of Winds and Tides is obſerved about the Equinoctials.

UNder the Equinoctal there is indeed always a ſwelling of the Ocean, becauſe that being the greateſt Circle of all, the Waters conſtantly tend thither for the equal preſervation of ballance, as we have before reaſoned, yet this ſwelling is then greateſt, when the Sun is there vertical. For then the Current and motion of the Sea is moſt impetuous, and extending it ſelf every way, it makes even the remoteſt Seas feel the effects of it's riſing. It is not then ſtrange that about the equinoctials the Seas are moſt agitated, and that then (beſides others) are raiſed theſe fearfull tempeſts which are called *Hurricanes*. and,

For therefore it be almoſt the vulgar opinion that theſe tempeſts are for-

fortuitous and casual, and that no certain reason can be given of them; yet seeing they do at set times, and in set places for the most part recur, the nature of them ought not to pass far occult. But that even as the other motions which happen in the Sea and Air, are limited by certain bounds and laws, so also do I think that the times and manner of these Tempests may be fore-known and predeterminated.

If therefore we do make it our business diligently to inquire into the time, when these tumults and seditions of Sea and Winds do arise, we shall find that it happens most about the end of Summer, when the Sun is hastening back from the Solstices to the Equinoctial. For then happens the turn of the yearly motion, whereby (as we have said) the Seas decline from South to North, and again from North to South. Now seeing all turning or reciprocation occasions an unequality of ballance or level, it must needs be, that in that time

when the Seas alter their courſe, and flow back again from South to North, or from North to South, there ſhould ariſe great Storms. But becauſe in all places the caſe is not the ſame, and that ſome places are more diſturbed than others, it will be neceſſary to obſerve a few things, from whence a conjecture of the reſt may be made. And that we may not confound together many kinds of Tempeſts, we ſhall only treat of *Hurricanes*, as being the moſt violent and impetuous of all others. But it will be to no purpoſe to tell what they are, ſince examples and hiſtories of them do every where occur. It is known that from a previous calm, Salt Shores and other indications, they are foreknown. It is alſo well known that when they are a coming, the Seas are whirled round in a circle. Nor are skilful Mariners ignorant, that they happen not in the middle of the Ocean, but only in places that are near the Land; and that the nearer they are to land, the fiercer they are. Where-

fore

fore prudent masters of Ships who who take care to preserve their vessels, leave the Shores and Harbours, and at that time put out to Sea, that they may avoid the danger. Yet I think they do mistake themselves, in that they always distinguish them from other tempests, as from [water spouts] and those they call [*Travados.*] For they who are in the middle of this Storm, where the danger is somewhat less, call it a [Spout] but such as are somewhat more distant a *Hurricane.*

It is likewise to be observed, that as to us who live in the Northern Hemisphere, the times of the year are different from these that happen to them who inhabit the Southern Hemisphere, so likewise the seasons of the Seas motions disagree. Under the Equator indeed, the same is the case of both Equinoctials. But when in this our Hemisphere *Hurricanes* do happen when the Sun returns from the Tropick of *Cancer* to the Equinoctial; on the contrary, in the opo-

ſit Hemiſphere they are moſt obſerved, when the Sun from the Tropick of *Capricorn* again viſits the Equinoctial.

Now then ſuppoſing what we have ſaid, that *Hurricanes* do ariſe from the converſion and turn of the yearly motion of the Seas, I think it may without any difficulty be gathered, where it is that ſuch Tempeſts never happen, and in what places they do very often, and for moſt part at the forementioned ſet times occur. Upon all the coaſts of *Europe*, and on that part of *Affrica*, which reacheth as far as *Cape Verd* although very vehement and ſtrong Winds do often blow from the Sea, yet (for what I know) there were never, or exceeding rarely any *Hurricanes* obſerved in theſe places. For upon theſe coaſts, the changes and viciſſitudes of the yearly motion do not occur; or if they do, they are altogether inſenſible. On moſt part of the coaſts of *Europe*, there is but one general motion obſerved, whereby the Seas ſet from Weſt

to

to East, as we have already several times declared. But the farther we put off from the *European* Shores in our course Westward, the more is this yearly motion perceived. Therefore in that *Sea* which washeth the opposit coasts of *America*, the above named Tempests are anniversary, and that at a set time, to wit, when the *Seas* begin to flow back from North to *South*.

And as (according to what we have said) the situation and motion of the *Seas* which lye on the North of *China* and of those that wash the opposit coasts of North *America*, is the same; so likewise the condition of the Currents and Tempests is in both places alike. When after the *Summer* solstice the *Sea* begins to flow back from North to *South*, and especially about the Autumnal Equinox or somewhat later, there arise so great *Storms* and Tempests in the Ocean that lyes betwixt *China* and *Japan*, that scarcely is navigation in any other place more dangerous.

Now as we have said that these commotions are more conspicuous upon the Shores, and that at a set season, according as the Shores are more or less remote, and therefore sooner or later receive the Tides, as in other places the same is manifest, so especially in the River of *China* which they call [*Che*] it is to be observed. For in the Mouth of this River as far up as the City [*Hauchew*] heretofore called [*Chinsai*] when the Current of the *Seas* changeth, which happens in *October*, there appears so great a Tide, that people flock thither from all places to gaze upon it as a miracle.

And if we consider the *Seas* of the *Southern* Hemisphere, we shall find the Tides and Tempests which happen there; to observe the same course and Period, as these do which every where occur in our Hemisphere. For upon the coasts which lye beyond the Tropick of *Capricorn*, and look Westward, there never happen any *Hurricanes*; but upon *Shores* that look towards

towards the East, they are very often observed. Upon the coast of *Chile*, and on the Western Shore of the Island [*del Fuego*] although other Tempests do appear; yet (for what I know) there were never any *Hurricanes* beheld, when notwithstanding the same do often rage on the opposit coast, which reacheth from the mouth of the Silver River to the Streights of *Magellan*, and farther. Neither are there any observed on that coast of *Affrica* which lyeth to the West, and reacheth from the Winter Tropick to the *Cape of good hope*, when nevertheless they are often seen on the contrary Eastern Shore, which is extended from the *Cape of good Hope* when nevertheless they are often seen on the contrary Eastern Shore, which is extended from the *Cape of good hope*, to the Island *Madagascar*.

Now what we have said that the fore named tempests do in the Spring time happen in the Southern Hemisphere, ought not to lose it's credit, because that at the *Cape of good Hope*

the same Storms are observed also in the Autumn, which do strangly afflict Sailers. For by reason of the motion of the *Indian* Sea which we told you before does decline Southward, there happen every year about this Promontory two turnings or conversions of the Sea. The reason of the Tempests that there happen in the Spring time is clear, for that which we call Spring, the inhabitants of that Promontory call Autumn. But the Autumnal Storms happen there from the turning of the *Indian* Ocean, which about the time of the Equinox, and after directs it's course towards that Promontory as hath been said before. But concerning these and some other peculiar motions of the Ocean and Winds, we shall have occasion to treat more amply in another place. So that for our present purpose I think what we have said may be sufficient.

CHAP.

CHAP. XXIX.

The way of making an Aeroſcope or Weather-Glaſs, whereby to foreknow approaching Tempeſts.

SEeing that many have wrote very much of the ſigns whereby the approach and qualities of future Winds and Tempeſts may be foreknown, and yet that there are none who have preſcribed any way which does not very often fail: I think it will not be amiſs, here to inſert the conſtruction of an Aeroſcope or Weather-Glaſs, by none (that I know of) hitherto obſerved, whereby if I miſtake it not, it may be moſt certainly known, what the ſtate and condition of the Air is, and if any Wind or Tempeſt be to be feared. We have lately ſhewn in a writing concerning light, by what means the Altitude of the Air by the help of Quick-ſilver might be known. And though there are ſome that think this way

not

not sure enough, seeing that the condition of the Air is not every where the same, and that according to the diversity of seasons it undergoes great alterations, yet this objection is so far from weakening the rule and measure that we proposed, that it does rather very much confirm what we have said. For what happens to the Air, the same does likewise to the Quick-silver contained in the Tubs or glass Pipes. And as the Altitude of the Air is not always the same, so likewise the height of the *Quick*silver is not at all times alike. About half a years time I observed the diversity of Level in several Glasses, and found that betwixt the greatest increase and decrease there was the difference of a fourteenth or a little larger proportion, wherein sometimes higher and sometimes lower the measure of the Air and *Quick*silver consisted.

I likewise observed that whensoever any Wind or Storm rises out of the Sea, the height of the *Quick*silver does piece and piece manifestly sink, and

and that exactly according to the proportion and degrees of the blustering *Storm*. And when it abates and a calm returns, the *Quicksilver* again ascends. Now seeing that in our Countreys most part of *Storms* come from the *Sea*, and that they are seldom occasioned by land Winds, as it happens also in other Countreys, especially where there are no Mountains; hence it is that when the Winds blow from the Sea, the *Quicksilver* always mounts up, and when they do again cease, or Land Winds blow, it again descends. For seeing that the Air which is over the Sea, is for the most part higher, than that which extends it self over the earth, hence it happens that this returning and meeting the Sea Air, should of necessity raise it higher; and this concourse is the cause that these gusts which proceed from the Land are less violent. But the Sea-Winds falling down from a higher level, and meeting with a thinner Air, have therefore a more vehement Motion.

Further-

Furthermore I judg this experiment to be of so great usefulness, that I know not if any other so secure and proper can be divised for the foretelling of Tempests. For although we can not thereby certainly affiix the time when any Tempest shall happen, yet if (I be not deceived) it may be certainly foreknown, when there is no danger, or when otherways the Air is in such a state that some storm or Tempest may arise. If the *Quick*-silver be at the lowest, then there is no danger threatned from Sea-Winds. But if the same be advanced to it's pitch, we need not fear any Land-Winds; but then the Air is in such a state that a Tempest may rise from the Sea; if which do follow, then the *Quick*silver swiftly and violently descends. But if it follow not, the Quicksilver decends by degrees, until it return to it's set measure.

And I do not at all doubt, but that if they who are at Sea would carefully consult such Glasses, they might from

from thence collect more, and certain presages, from whence they might clearly know the state of the Air, and if any Tempest were threatned not only upon coasts, but even also and that perhaps more accurately in open Sea. For when the *Quick*-silver contained in the Pipes, is not sensibly asserted with heat or cold, but does always exactly represent the Level and Ballance of the Air, from whence the causes of Changes and Storms are to be sought; it seems altogether consonant to reason that the observation of this thing should prove very profitable to Navigatours. But for my part as long as this experiment is not approved by the testimonies of others, let every one think of it as he thinks fit, and I am satisfied.

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